Framing the Active Learning Classroom

Clicker questions and slides to explain active learning to students

About this project

This is one items in a set of materials is compiled for instructors to draw upon in order to frame non-traditional modes of classroom teaching. Our hope is that these materials can enhance student enthusiasm for and reduce student resistance to such techniques, thus improving the experience of instructors and students and supporting student learning. These materials are not research-tested; rather, they represent the wisdom and experience of practitioners who are using research-based instructional techniques. These materials have been shared by members of the science education community, primarily in physics. If you re-use these materials, please be sure to attribute the author (see License, previous slide).

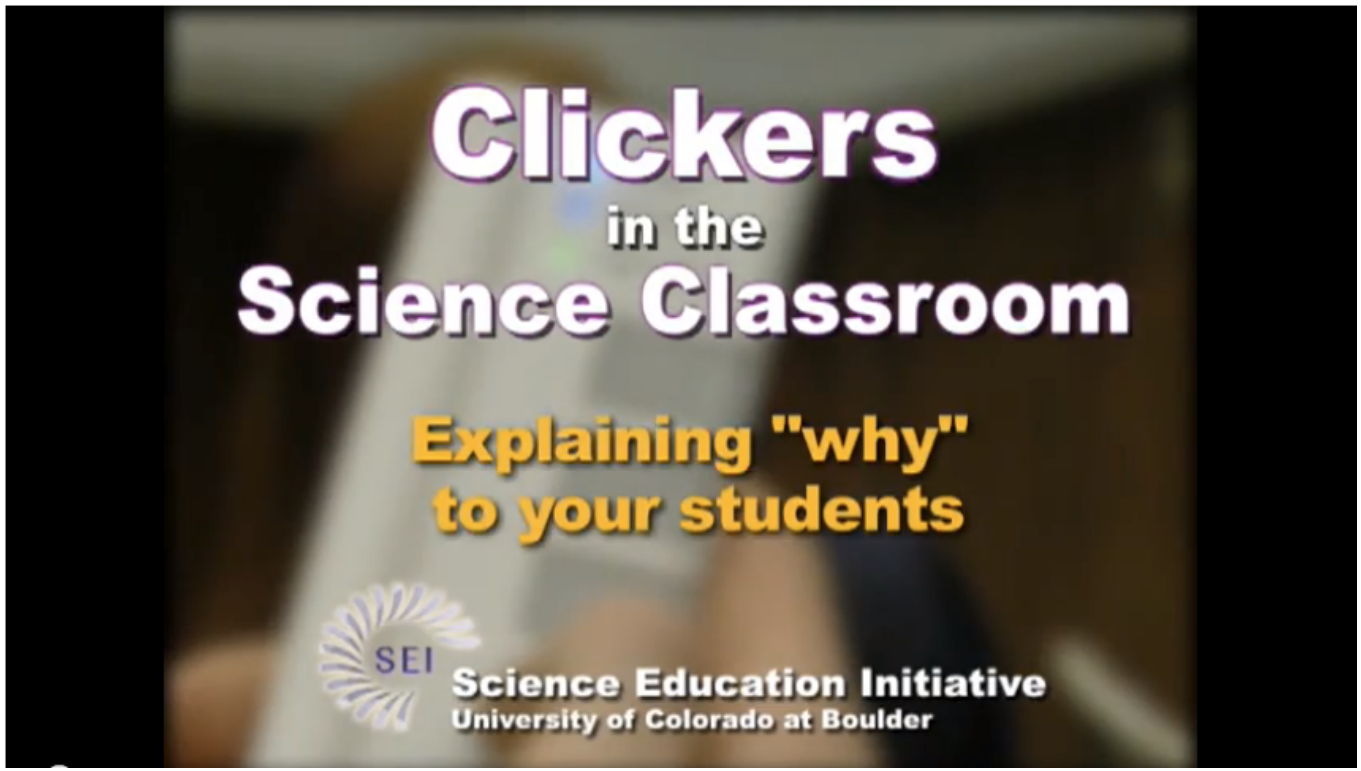
You can find the rest of these materials (slides, activities, etc.) at http://colorado.edu/sei/fac-resources.

For more information, contact Stephanie Chasteen, stephanie.chasteen@colorado.edu.

http://colorado.edu/sei

Tell your students why you're using clickers

- For an example of a first-day speech to students, and discussion of student buy-in, see video at https://www.youtube.com/watch?v=NGx7EzDQ-lY



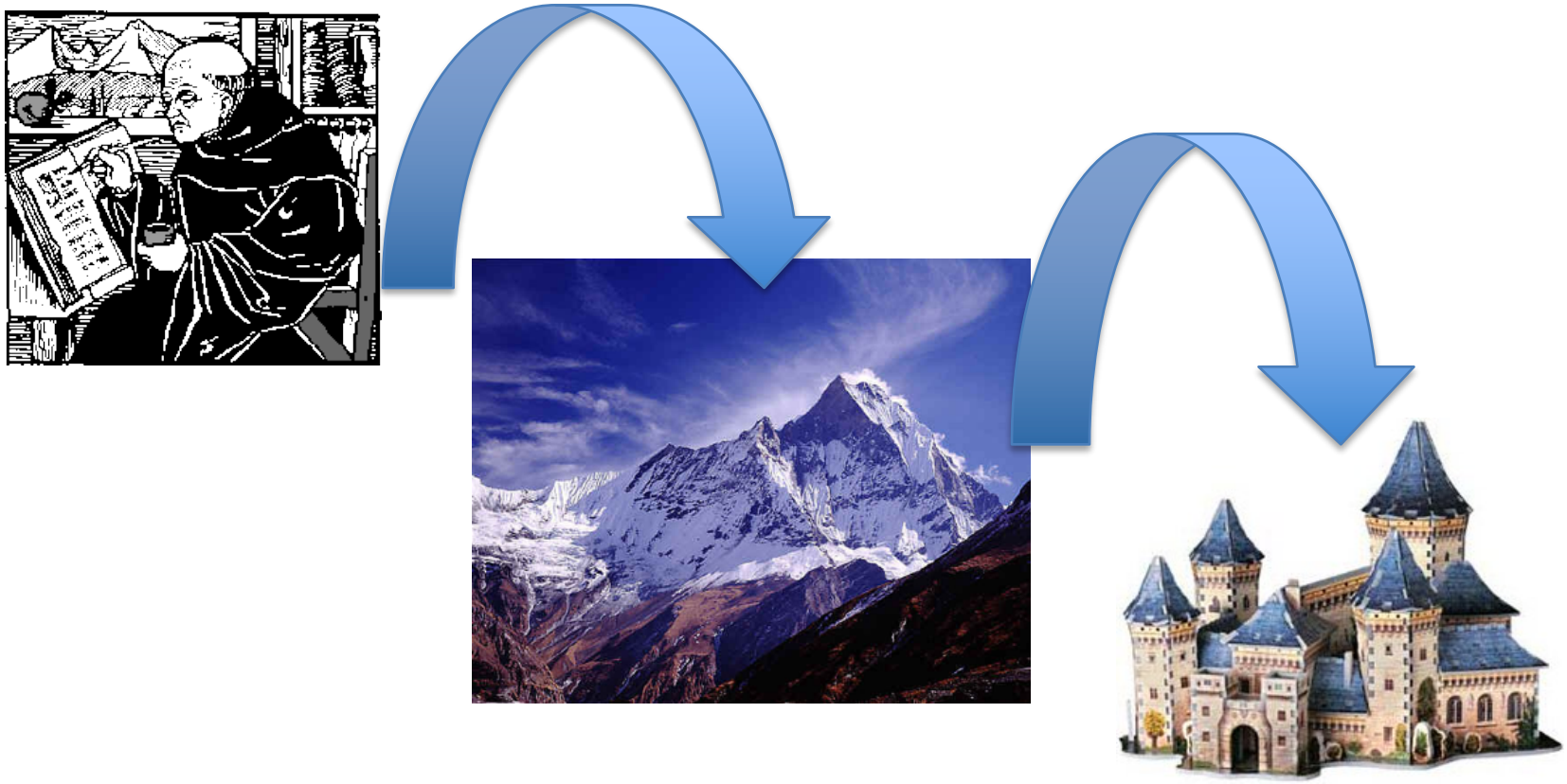
Beth Simon “Intro to PI”

The following slides were created by Beth Simon, Computer Science and Engineering, Director of the Center for Teaching Development, UCSD)

An example script is given in the notes, and a video walk-through of the slides is at http://www.youtube.com/watch?v=UYS5ofDCn4Q

More materials online at http://www.peerinstruction4cs.org/general-pi-tips/

Why do we have lecture?



Beth Simon, UCSD

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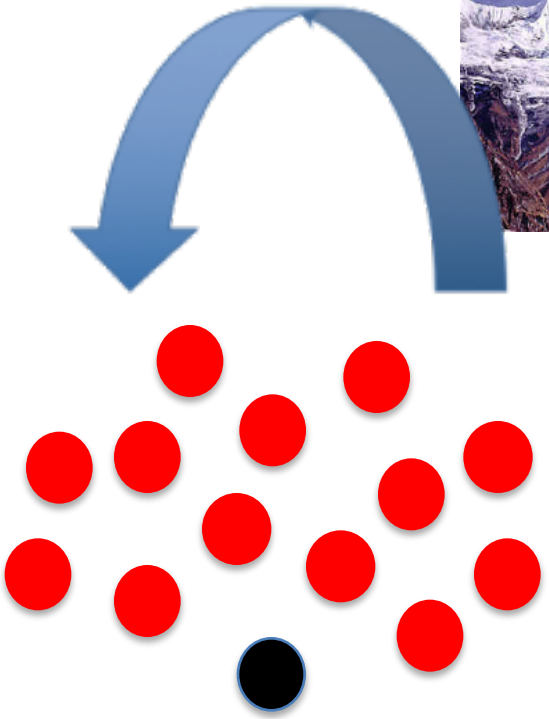
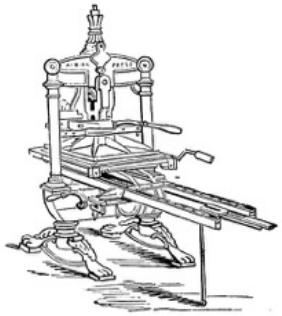


Beth Simon, UCSD

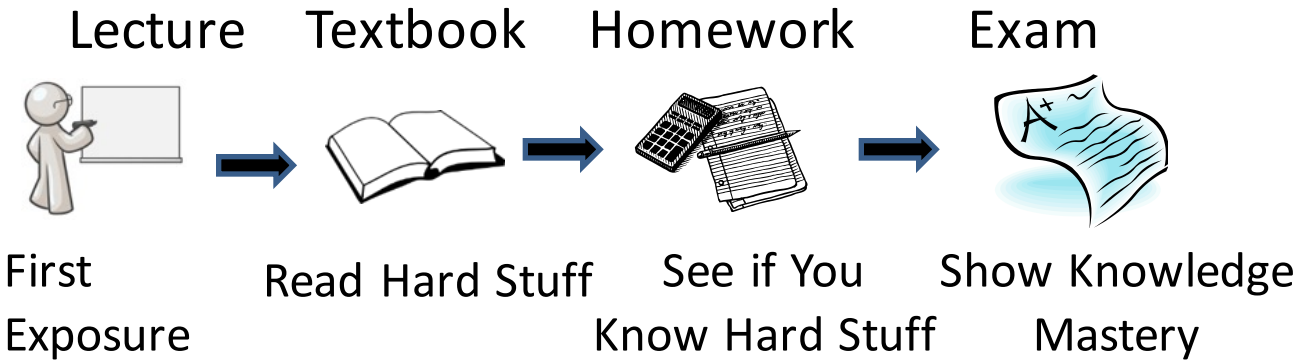
Why do we have lecture?

Beth Simon, UCSD



GREAT Innovations: The printing press, The web

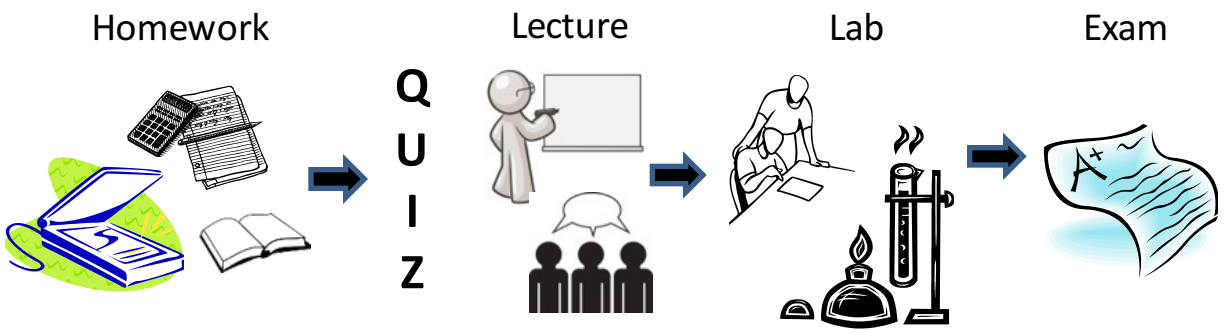
- You don't have the trust the monk!
  - Read it and analyze for YOURSELF!
  - If I rephrase it for you, what purpose does that serve?
- Traditional class structures often look like:



- You get very little opportunity for "expert" feedback

Beth Simon, UCSD

Peer Instruction-Based Design



- Greater opportunity for expert feedback!
- Research on how people learn:
  - Everyone constructs their own understanding
    - I can't dump understanding into your brain
  - To learn YOU must actively work with a problem and construct your own understanding of it

Beth Simon, UCSD

Lecture: Peer Instruction

- Are you prepared? (quick quiz at beginning of class, using clickers)
- Pose carefully designed question
  - Solo vote: Think for yourself and select answer
  - Discuss: Analyze problem in teams of 3
    - Practice analyzing, talking about challenging concepts
    - Reach consensus
    - If you have questions, raise your hand and I or the TAs will come around
  - Group vote: Everyone in group votes
    - You must all vote the same to get your point
  - Class wide discussion:
    - Led by YOU (students) – tell us what you talked about in discussion that everyone should know!

Beth Simon, UCSD

Giving out Candy

- To people willing to
  - Ask a question
  - Share an explanation
  - Summarize what their group talked about
- Your explanations are CRITICALLY HELPFUL for fellow students' learning

Beth Simon, UCSD

2-Slide Sequence

- *Just the second slide can be used, if you just want to "say" the material from the first slide.*
- *Good for reminding students why we are using peer instruction*

- *Walk through of these slides is at end of video at* http://www.youtube.com/watch?v=SKGsvi5OfN0

Beth Simon, UCSD

Couldn’t you PLEASE just tell it to me?

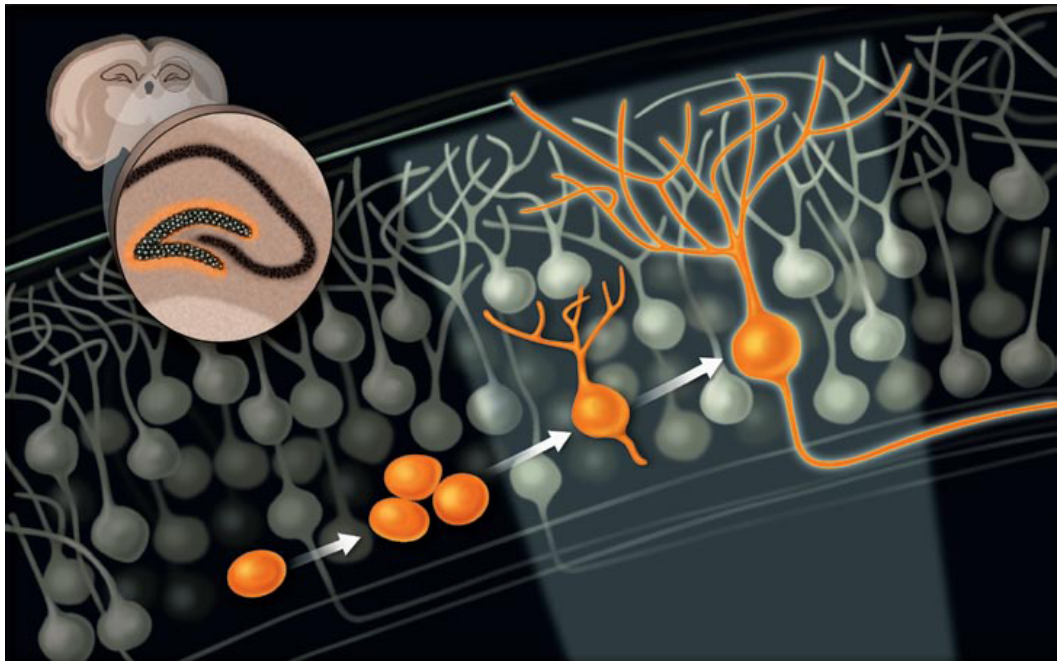
I know how to learn from lecture!
Can’t you just explain it?

Well, clickers were fun, but the professor made me learn it on my own! It would have been easier if he’d just lectured!

Beth Simon, UCSD

Learning Requires Your Effort

- I can't do the learning for you
- Higher-level learning = brain development



Development of new neurons in response to difficult learning task
T. Shors, Sci. Amer. Mar 09

It's like muscle development!

Strenuous, repeated effort -> New Muscle Cells

Strenuous, repeated effort -> New Neurons, Links!

Beth Simon, UCSD

Cynthia Bailey Lee

- Attribute to Cynthia Bailey Lee, Computer Science and Engineering, UCSD
- *Peer Instruction*

What do you do in class?

(before class, you prepared yourself by reading the textbook and preparing for the in-class reading quiz)

1. I ask a question
2. You first answer it by yourself
3. Then discuss in assigned groups of 3-4 students
   - Like a jury, you must come to a unanimous decision
   - Answer the question a second time
4. I will ask groups to share their insights, and I will provide additional clarification as needed

"But Prof. Lee, wouldn't it be more *efficient* if you just taught us the right answer to begin with?"

- Have you ever heard of an aerobics class where the instructor did all the exercises at the front of class, while the class just sat and watched attentively?
- **Me neither.**
- To learn, you must do the work with your own muscle (your brain).

Cynthia Bailey Lee, UCSD

What do you do in this course?

- Prepare your brain for maximum in-class learning
  - Reading, reading quizzes
- In class: engage with your neighbors and the class, engage with the ideas
  - Turn them upside down and sideways, think about what common errors or misconceptions might be
- Seek help and seek to help others
  - In class, moodle forums, office hours, discussion section
  - I expect each class member to contribute to an environment of mutual aid and cooperation

Tips for a good group discussion

- Take turns being the first one to talk
- Once you all agree on the answer, don't stop!
  - Always go over each wrong answer and explain why it is wrong
    - Also interesting and useful to think about why somebody might be tempted to choose it—how was Dr. Lee hoping to "trick" somebody by including that wrong answer?
  - Even if your group-mate has said something very clearly and correctly, it's a good idea to **repeat it yourself**
    - "So, what I think you said was, …"
    - **Might seem pointless, but your brain will remember better if YOU say it too**

Edward Price

- Attribute to Edward Price, Department of Physics, CSU San Marcos
- *Peer Instruction Introduction*

Expectations

- This material is challenging, and involves more than just memorizing…
- You will be expected to think and analyze new situations
- To be good at this, you need *practice* and *feedback*, which is exactly how we will spend class time

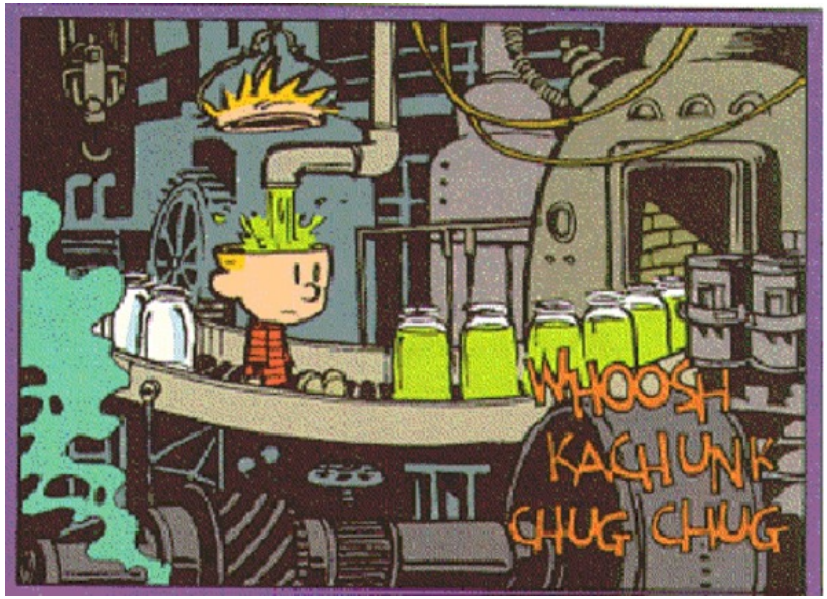
Expectations

- Most students are capable of succeeding in this class – this means you!
- I will try to create a course that facilitates your learning; **you** need to **participate**
- If you would like to do better, ask "Am I…
  - Coming to class (w/ clicker and workbook) and **actively** participating?
  - Reviewing your class notes?
  - Doing all HW on time?
  - Trying to understand the material, not just 'get it done'?
  - Asking questions when confused

Course components: class

Expect active involvement

- Bring workbook to class
- Bring your clicker (credit for participation)

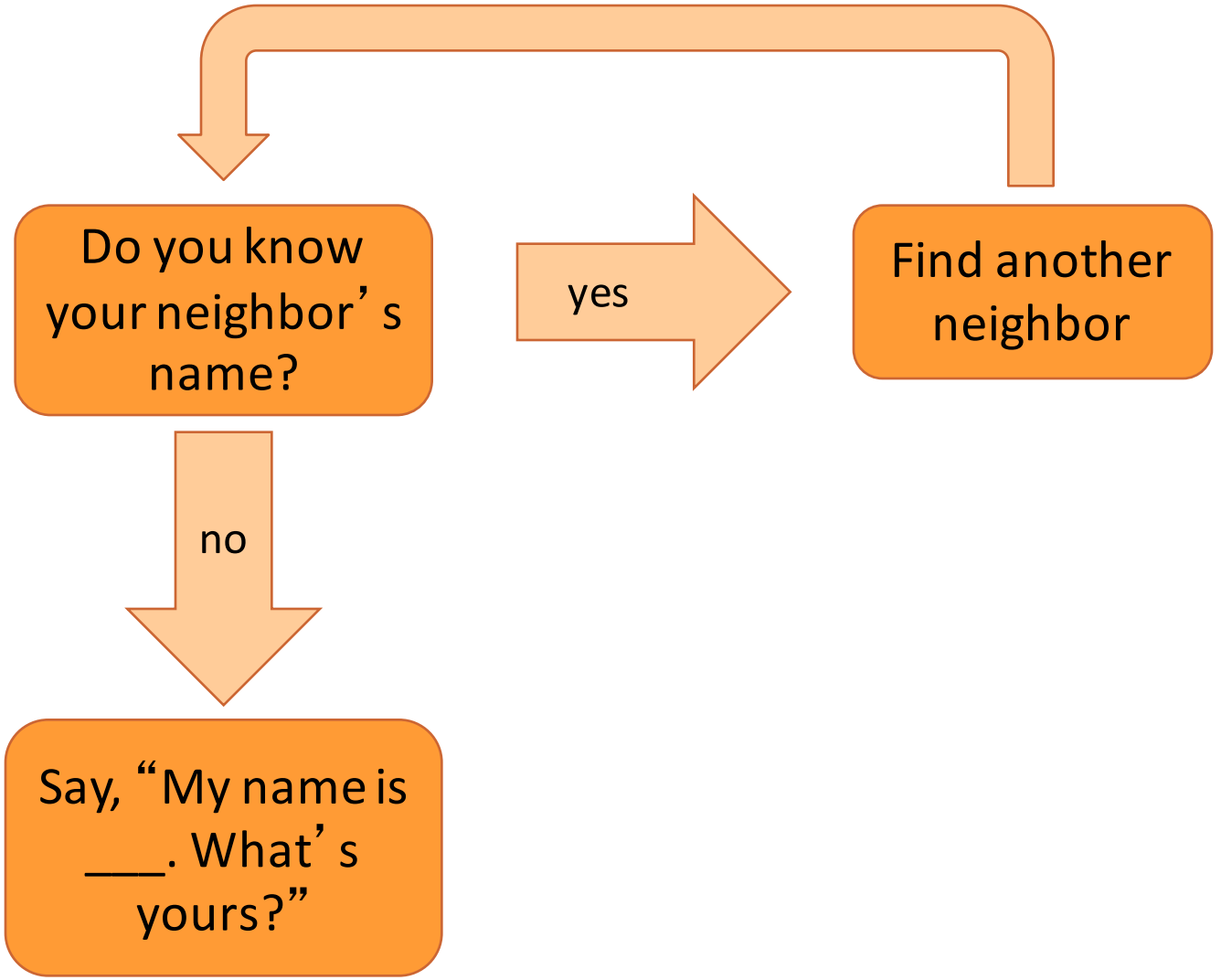


Edward Price, CSU San Marcos

Do you have a clicker?

a) Yes
b) No
c) Not sure

Meet your neighbor



Edward Price, CSU San Marcos

Noah Finkelstien

- Attribute to Noah Finkelstein, University of Colorado Boulder
- Modern Physics for Engineers course

Interpretation and Probability

You're on a game show:

There are 3 Doors (envelopes).

Two doors have goats (empty)

One door has a car (half-fast sandwich)

Interpretation and Probability

Audience Member -- -Pick Door (don't open it)

Monty Hall (me?)

opens a different door & reveals goat

Audience member:

Do you switch doors and why?

A = yes, but don't improve chances
B = yes, because better chances
C = no, it doesn't improve chances
D= no, I don't deserve to win
E= it really really doesn't matter

Interpretation and Probability

Who knows what, when.

Monty Hall (I) know where the car is the whole time

He would not reveal the car (tear up the gift certif).

He can always show the goat

A = yes, but don't improve chances

B = yes, because better chances

C = no, it doesn't improve chances

D= no, I don't deserve to win

E= it really really doesn't matter

Interpretation and Probability

Who knows what, when.

All Possible Scenarios

Door	A	B	C
1 = you choose	Car	Goat	Goat
2 = my door	~~Goat~~	Car	~~Goat~~
3 = my door	Goat	~~Goat~~	Car
Switch	lose	win	win

REMEMBER:

I would never tear up the sandwich (reveal the car)

That's why it's not 50/50

Some take-home messages

- We can make rational choices
- It depends on understanding probabilities & interpretations
- You should be engaged (you'll learn more)
- This class will provide you plenty of opportunities -- but you have to play

Some additional possible interpretations:

- Life is like a game-show
- Don't contradict the Professor

Guiding principles: (basis for how course is run)

1. People understand concepts by seeing, discussing, and applying them, not by passively listening to explanations.
2. Understanding physics (& solving problems that develop understanding) is a learned skill, like golf or playing basketball or violin.

   Takes time, effort, and practice. Research says better retention if sustained effort rather than cramming.
3. People learn best by sharing and getting feedback on their thinking--

   Student-student more often than student faculty.
4. Students learn most when they take the responsibility for what is learned.

Physics is <u>not</u> collection of facts
(it's magic)
((just kidding… it's better than magic))
<u>It is way of thinking.</u> *Only you can teach yourself to think!*
Analyzing, applying concepts, solving problems.

Attitudes and Beliefs*

Assessing the "hidden curriculum" - beliefs about physics and learning physics

Examples:

- "I study physics to learn knowledge that will be useful in life."
- "To learn physics, I only need to memorize solutions to sample problems"

*Adams et al, (2006). Physical Review: Spec. Topics: PER, 0201010

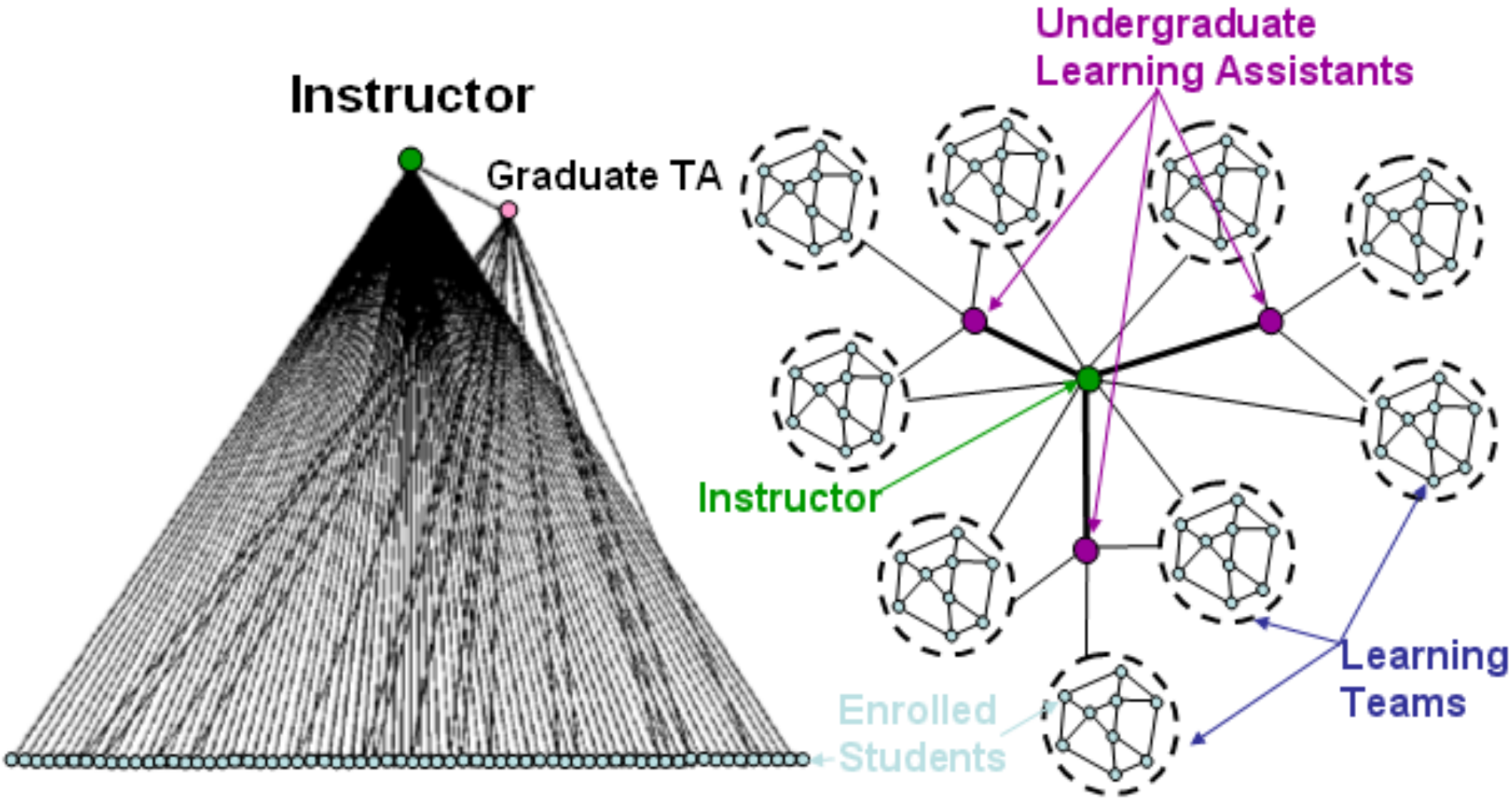
CLASS categories

	Shift (%) ("reformed" class)
Real world connect...	-6
Personal interest.....	-8
Sense making/effort...	-12
Conceptual.....	-11
Math understanding...	-10
Problem Solving.....	-7
Confidence.....	-17
Nature of science.....	+5

(All ±2%)

Teach by actively engaging students…
based on what they know . . .

Course Transformation with LAs



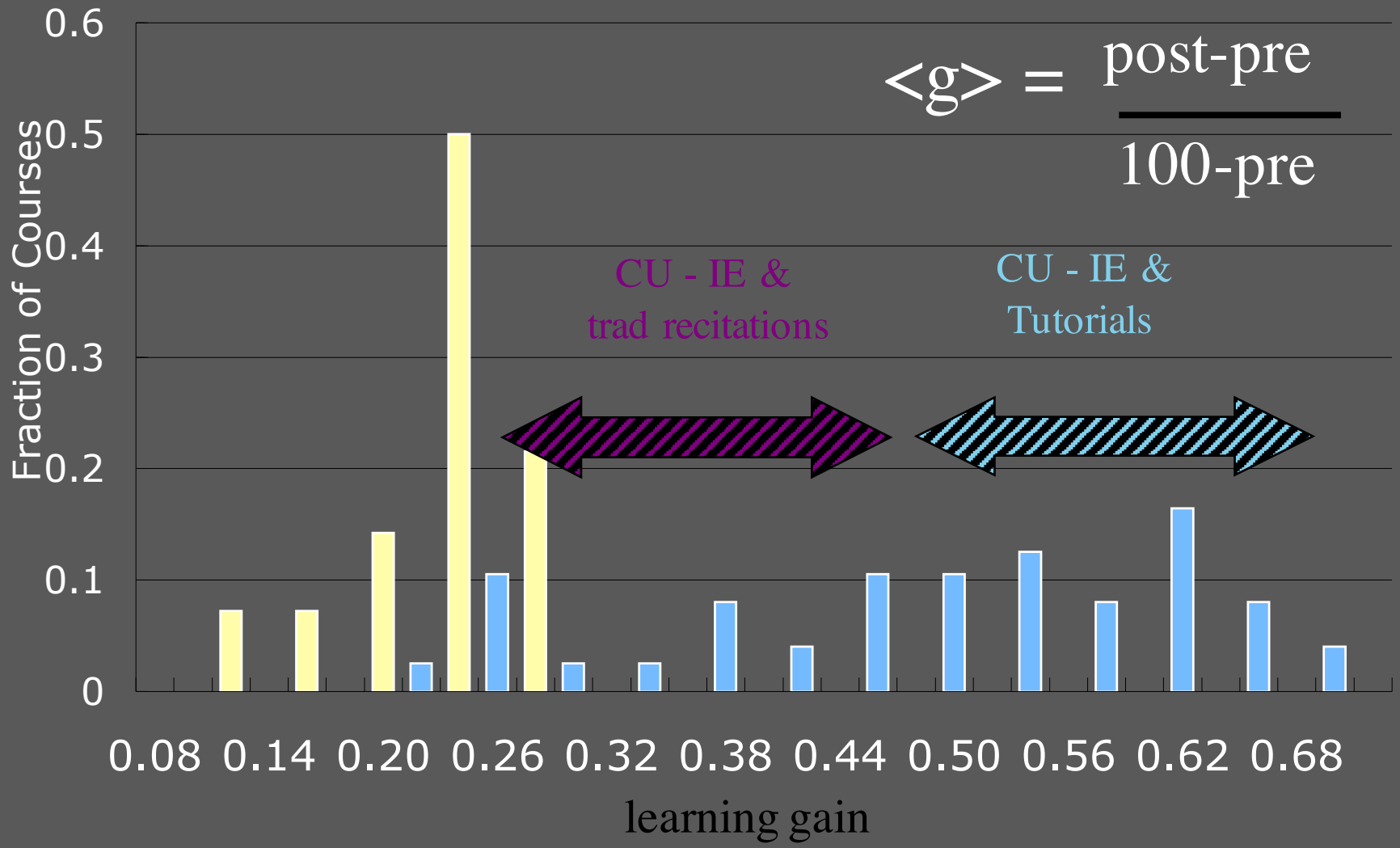
Traditional large enrollment lecture course: one instructor and a graduate TA to serve 200+ students

Course transformed using Learning Assistants to facilitate collaboration

Otero et al, *Science* 2006

Engagement Improves Learning

traditional lecture interactive engagement



Pollock & Finkelstein, Physical Review, 4, 010101 (2008).

Course Goal:

Every student learn everything!

If not important to learn, we took it out.

Expectations

- Most students are capable of succeeding in this class – this means you!
- I will try to create a course that facilitates your learning; **you** need to **participate**
- If you would like to do better, ask "Am I…
  - Coming to class (w/ clicker and workbook) and **actively** participating?
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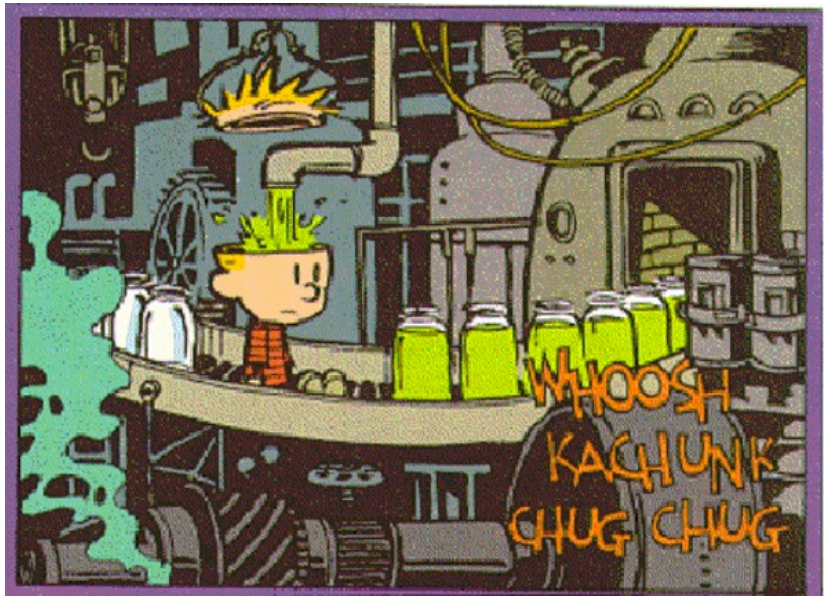
Course components: class

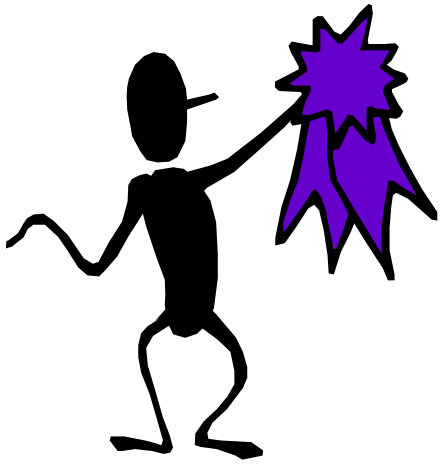
Expect active involvement

- Bring prelecture notes to class…
- Bring your clicker (credit for participation)



We provide you with opportunities to help you learn.
Content, problems, simulations, guidance, organization.

Reward activities and efforts conducive to your learning (grade)

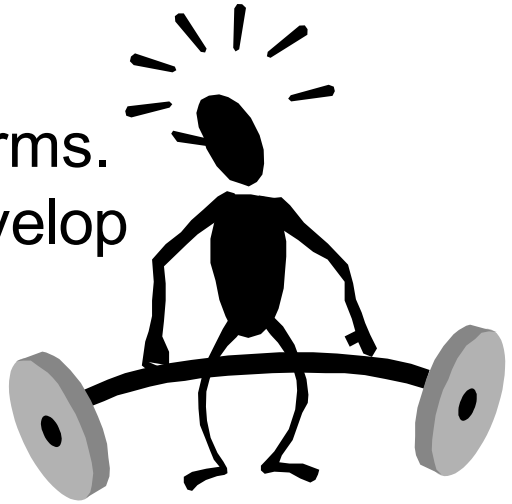


Learning only comes as result of your effort!

Model for learning 2130

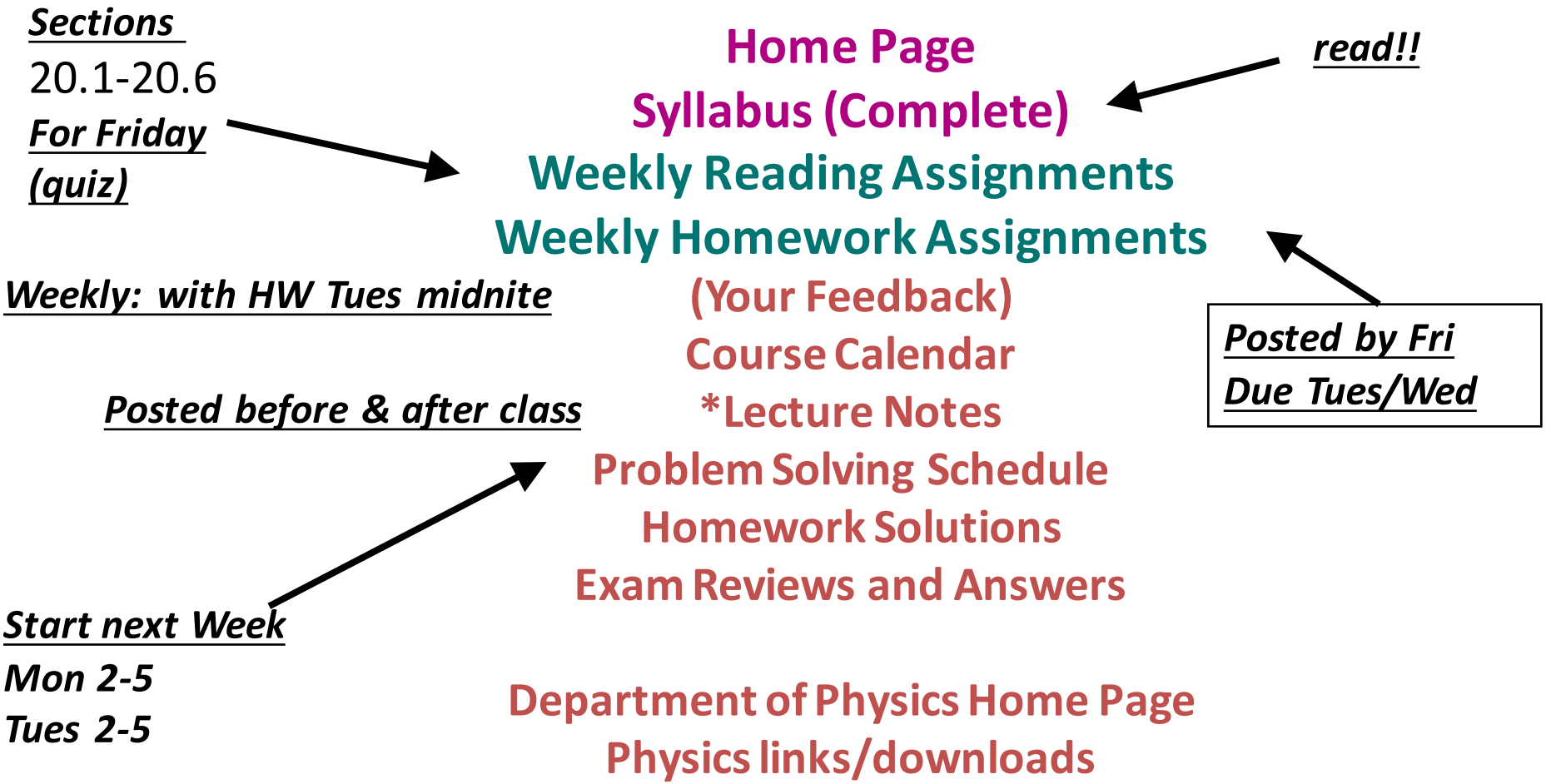
1. Reading before class- introduce ideas and terms.
2. Analysis and discussion in class- explore, develop basic ideas and understanding.
3. Master and retain ideas through use in extensive HW (4-6 hrs/wk)

(collaboration good, but submit own work)



Physics 2130 website, source of all knowledge!

http://www.colorado.edu/physics/phys2130



Important class rules:

1) No cell phones on, or newspapers in class.
2) Lots of physics discussion during clicker questions

Content survey (15 minutes)

Learn how much you know about modern physics already (hopefully not much)

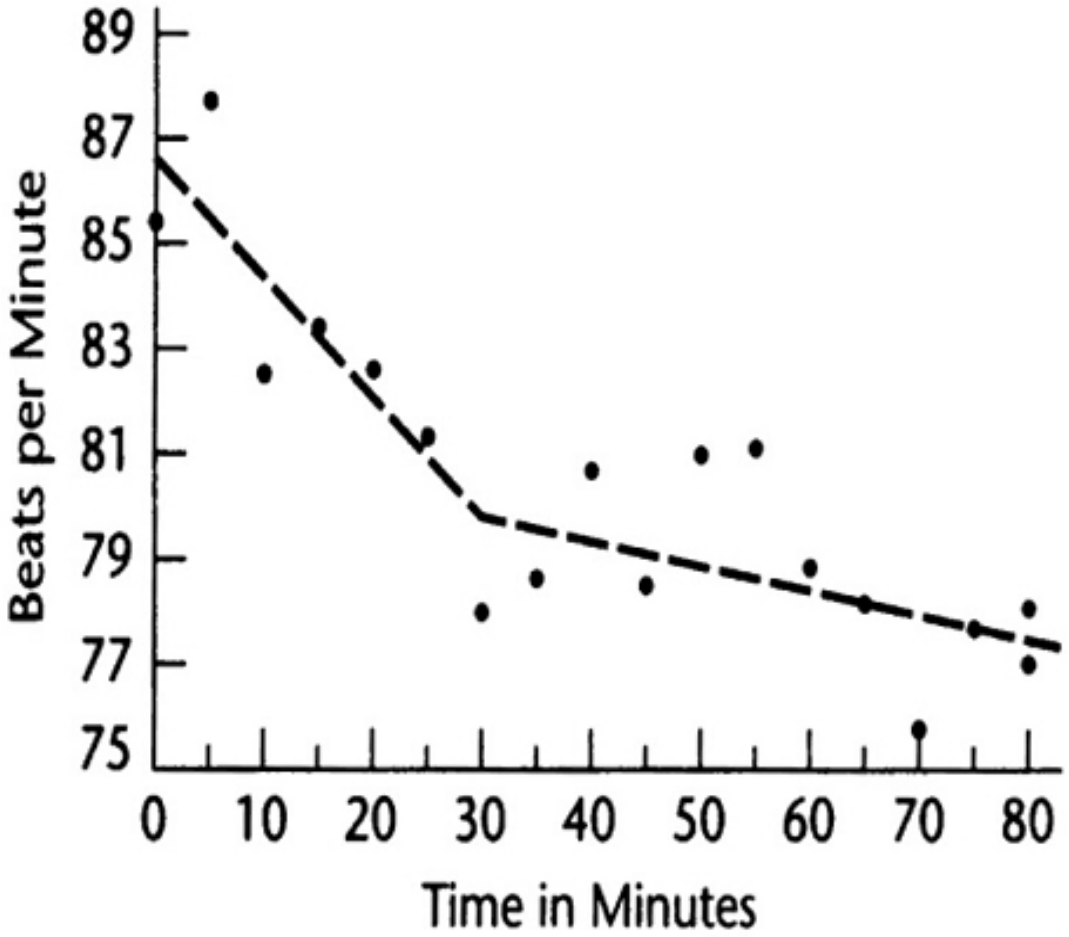
Purposes:

1. Find out what ideas you already know, so don't repeat.
2. What areas to focus on / emphasize
3. Find out how much you learn during the semester.

Ian Beatty

- Attribute to Ian Beatty, UNC Greensboro
- *See also Ian's many clicker questions for meta-communication with students, in the clicker question files.*

FIGURE 3.6. STUDENTS' HEART RATES IN UNINTERRUPTED LECTURES.



Bligh, 2000, What's the Use of Lectures? 2000, p.51; Hartley & Davies, 1978, *Programmed Learning and Educational Technology:15:207-224.*

Courtesy of Ian Beatty, UNC Greensboro

Last Serny, Flingledobe and Pribin were in the Berdlink treppering gloopy caples and cleaming burly greps. Suddenly, a ditty strezzle boofed into Flingledobe's tresk. Pribin glaped. "Oh Flingledobe," he chifed, "that ditty strezzle is tunning in your grep!"

Courtesy of Ian Beatty, UNC Greensboro. Originally from Todd Zakrajsek of UNC-CH

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When did Flingedobe and Pribin treppen?

Courtesy of Ian Beatty, UNC Greensboro. Originally from Todd Zakrajsek of UNC-CH

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What kind of caples did Flingledobe and Pribin treppen?

Courtesy of Ian Beatty, UNC Greensboro. Originally from Todd Zakrajsek of UNC-CH

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What did the ditty strezzle do to Flingledobe's tresk?

Courtesy of Ian Beatty, UNC Greensboro. Originally from Todd Zakrajsek of UNC-CH

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What was Pribin's reaction?

Courtesy of Ian Beatty, UNC Greensboro. Originally from Todd Zakrajsek of UNC-CH

Last Serny, Flingledobe and Pribin were in the Berdlink treppering gloopy caples and cleaming burly greps. Suddenly, a ditty strezzle boofed into Flingledobe's tresk. Pribin glaped. "Oh Flingledobe," he chifed, "that ditty strezzle is tunning in your grep!"

What do you imagine happened next?

Courtesy of Ian Beatty, UNC Greensboro. Originally from Todd Zakrajsek of UNC-CH

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Based on the incidents in the story, why do you think Flingledobe and Pribin went to Berdlink? Are they likely to return? Why or why not?

Courtesy of Ian Beatty, UNC Greensboro. Originally from Todd Zakrajsek of UNC-CH

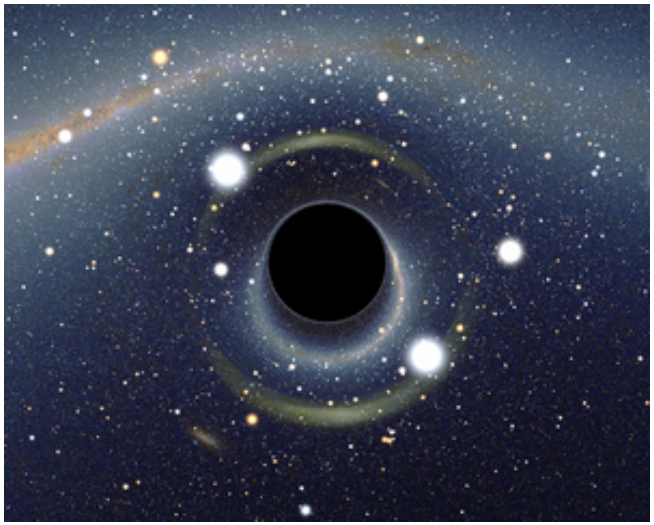
Douglas Duncan

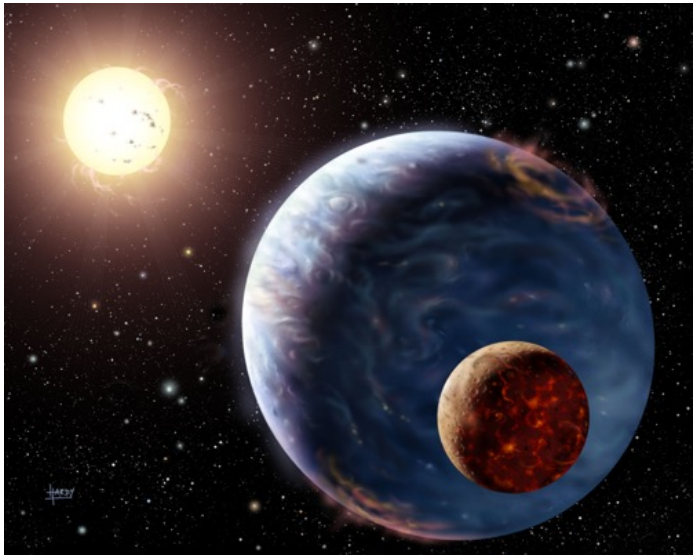
- Attribute to Douglas Duncan, Astronomy, University of Colorado at Boulder
- My class is a science class for NON-science students. That is why I spend time motivating the usefulness of their studying astronomy and science more generally
- You can contact Doug with questions at **Douglas K Duncan <dduncan@colorado.edu>**

How many of you are taking this class just because you love science?

A paradox!

In this class you'll come to understand some of the most amazing things in the universe! ….





Black holes…newly discovered planets… why the sky is blue…and more

Scientific questions affect your life…

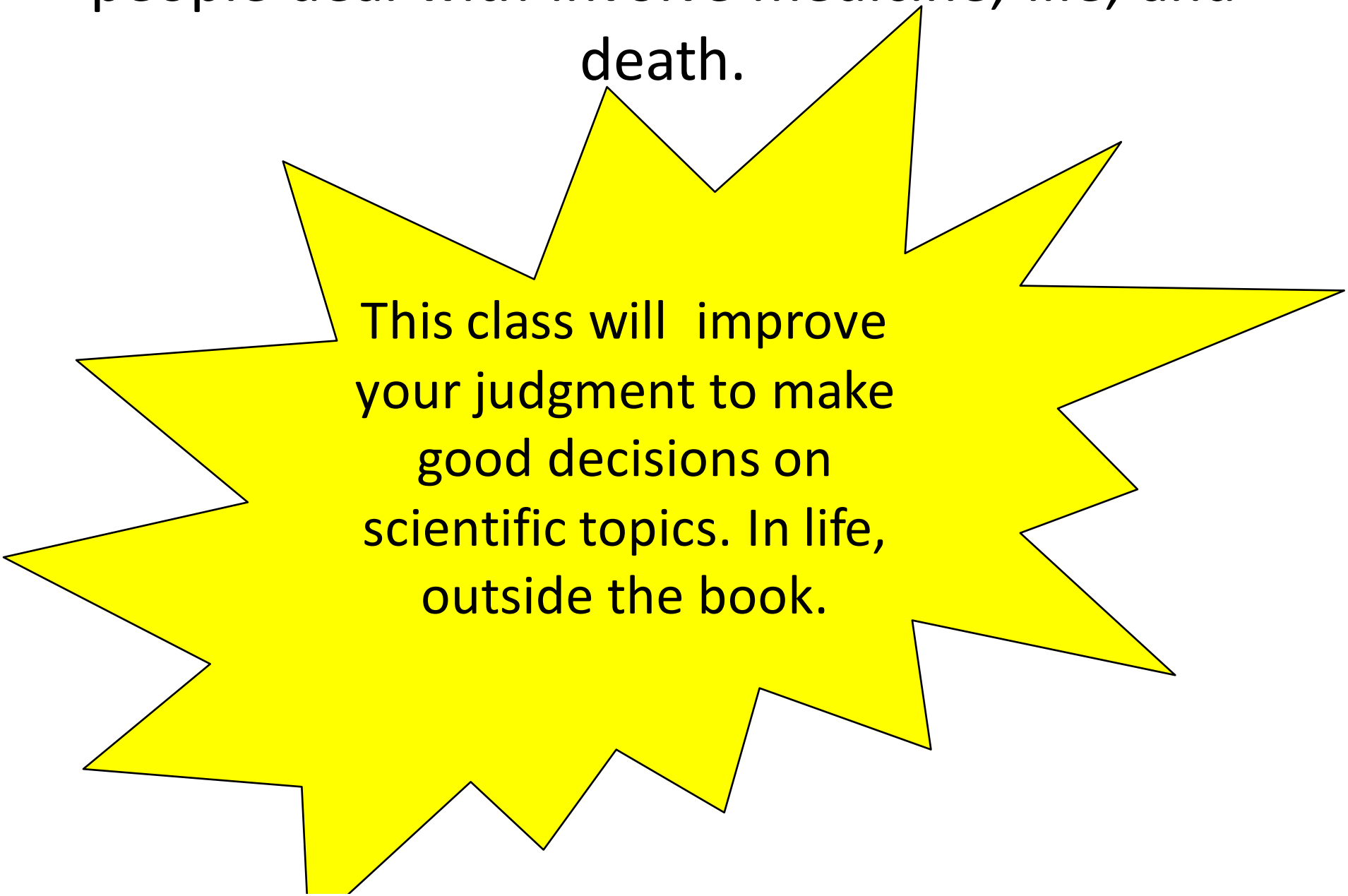
Is climate change a serious problem?

Will there still be skiing in Colorado when you're my age?

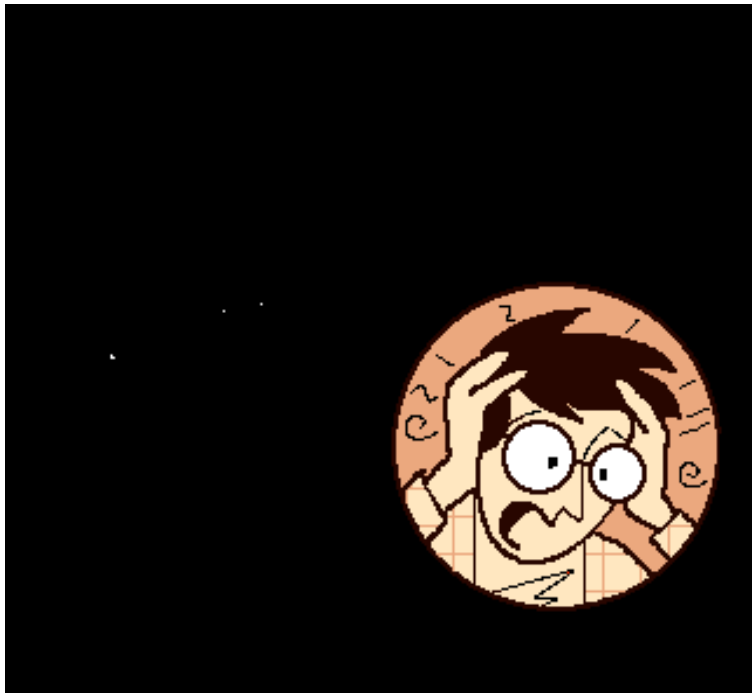
Could the evolution of viruses cause many healthy college-age people to die?

What sources of energy are the best choices?

The most important scientific questions many people deal with involve medicine, life, and death.



This class has less memorizing, but more thinking, than many science classes. We encourage creativity as much as possible.

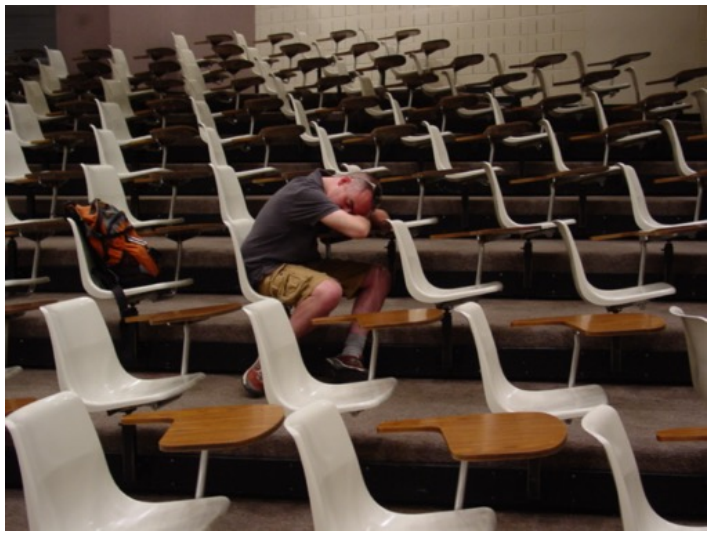


Why do I teach this class the way I do, less lecture, more student discussion ?

We've been teaching the same way for a long time…

2000 years ago

Today



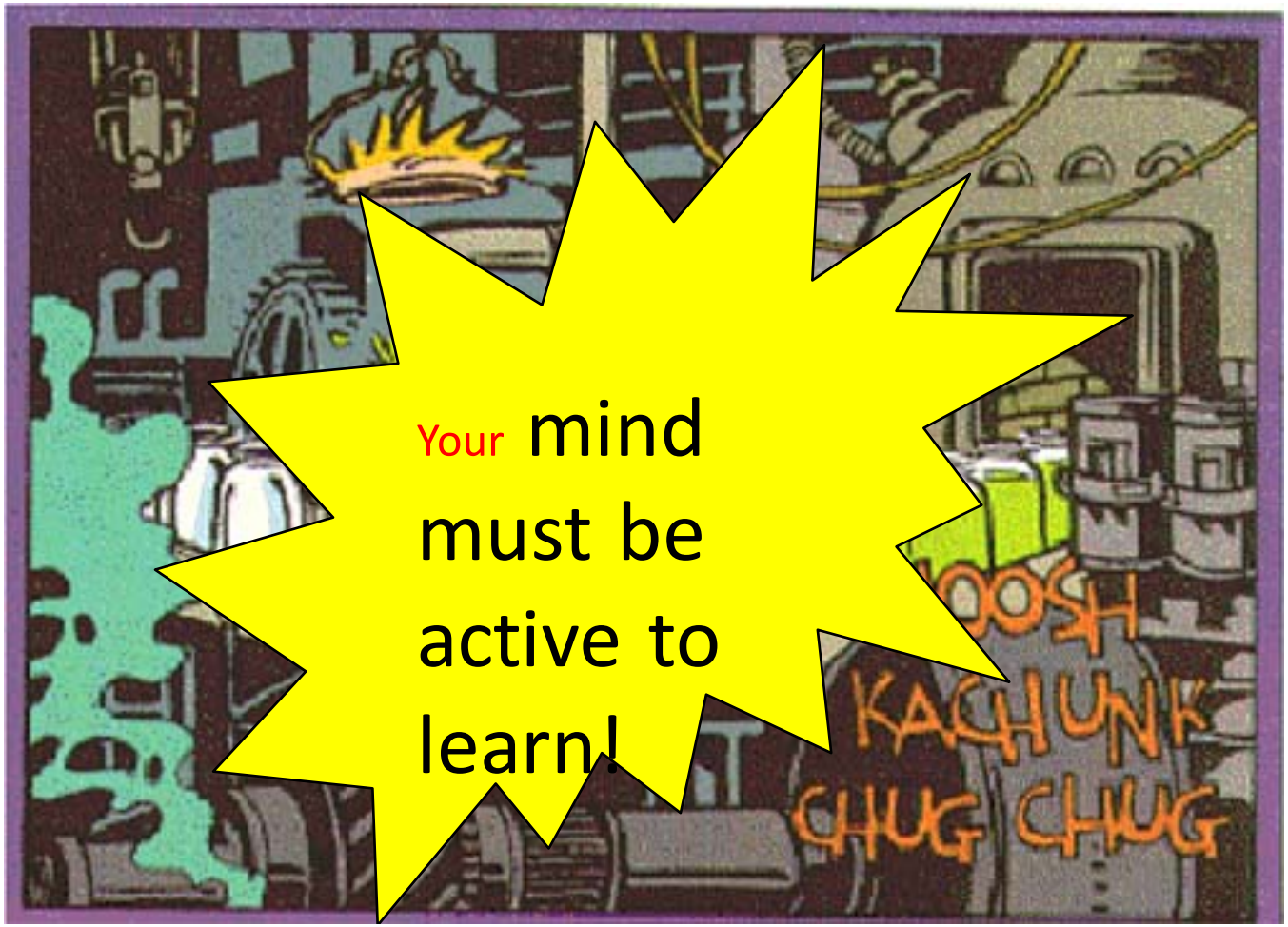
How effective is pure lecture ?!

In a lecture class with an interesting, clear, engaging teacher, what fraction of the material presented during the semester does a student typically learn **well**? (well enough to explain to someone else)

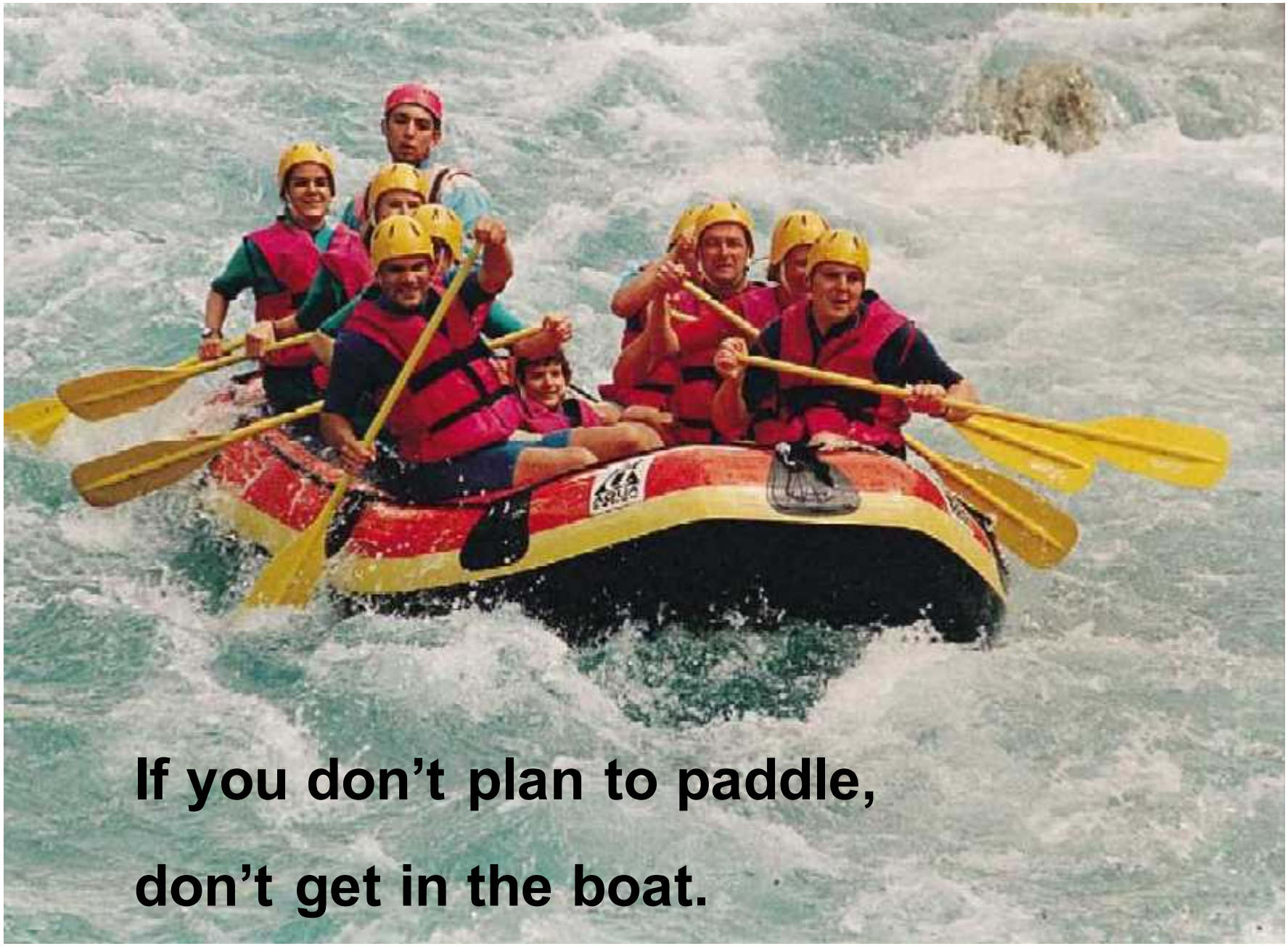
A. 90%
B. 70%
C. 50%
D. 25%
E. 15%

Traditional Model of Education

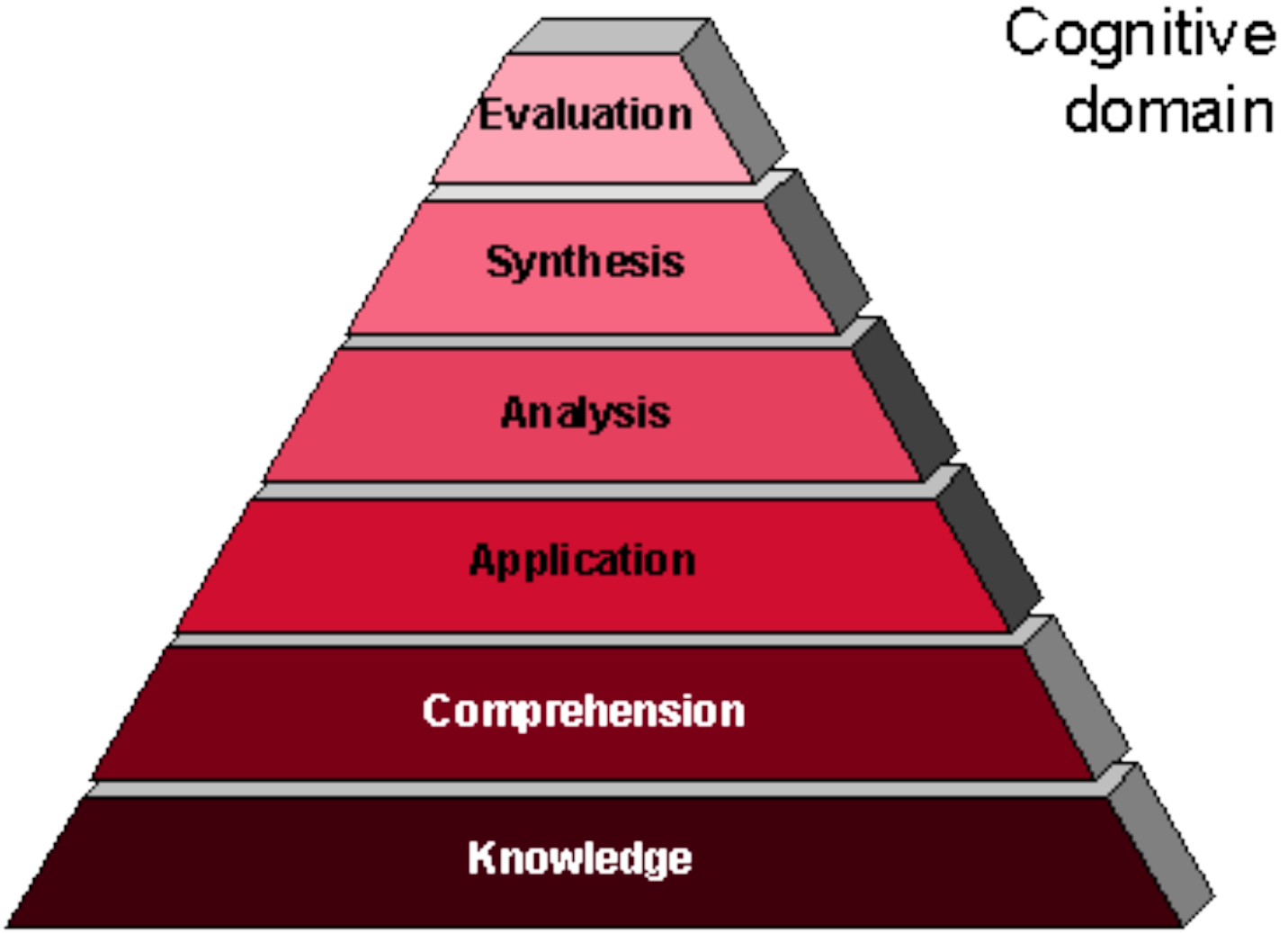
Individual ← **Instruction via transmission** — **Content**



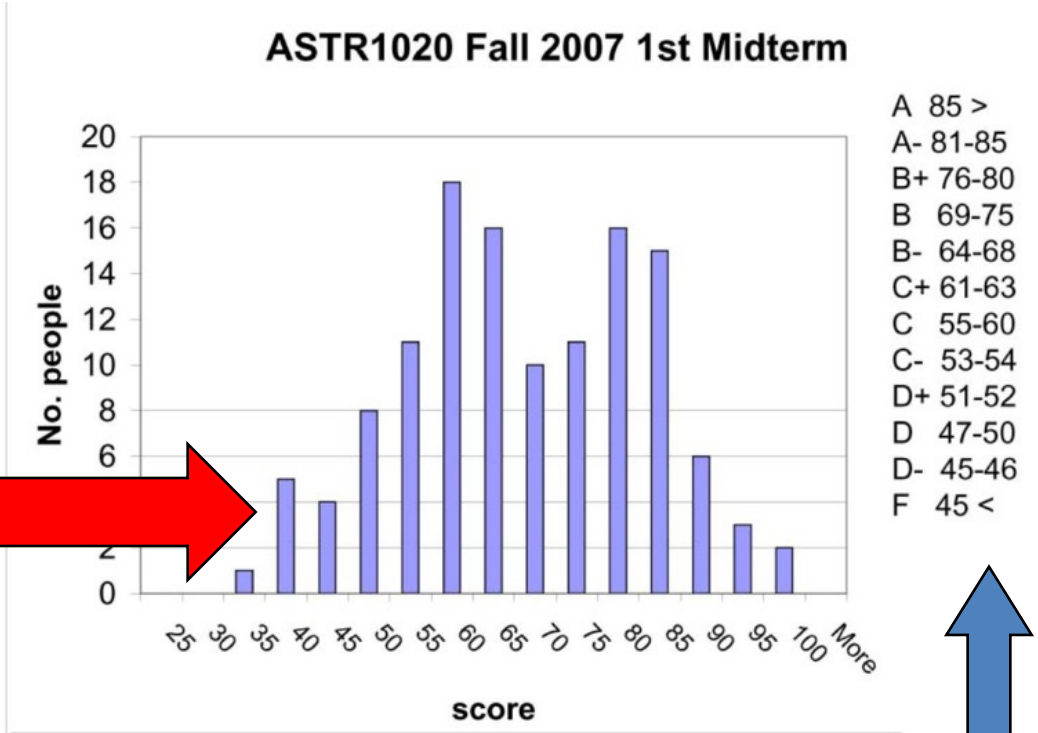
Is false!


If you don’t plan to paddle,
don’t get in the boat.

Bloom's Taxonomy

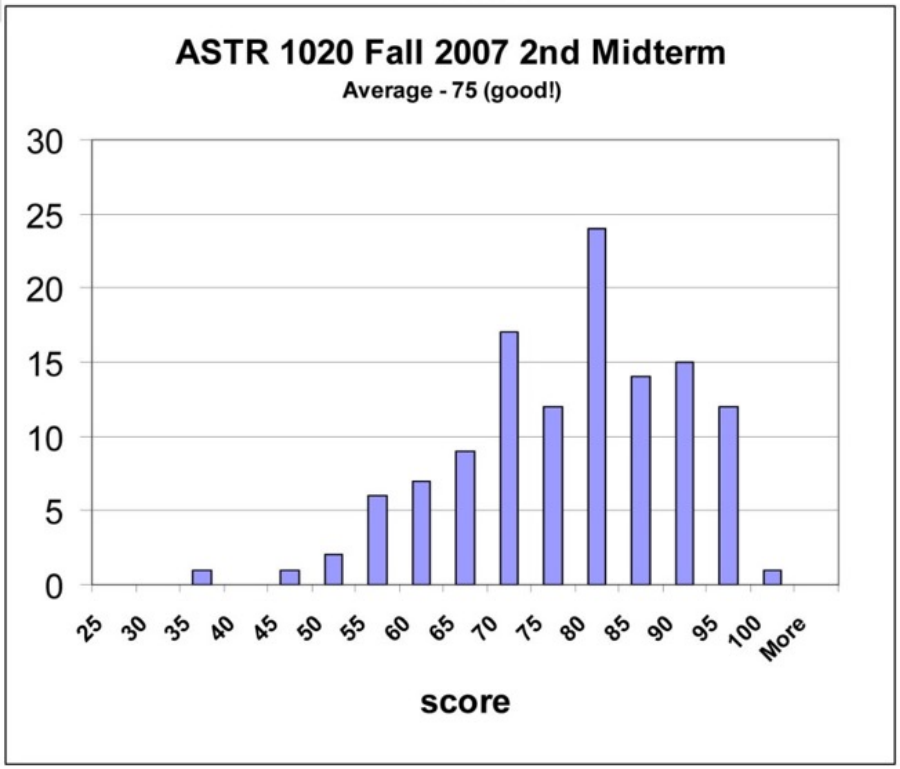


What's with all the D's and F's ??



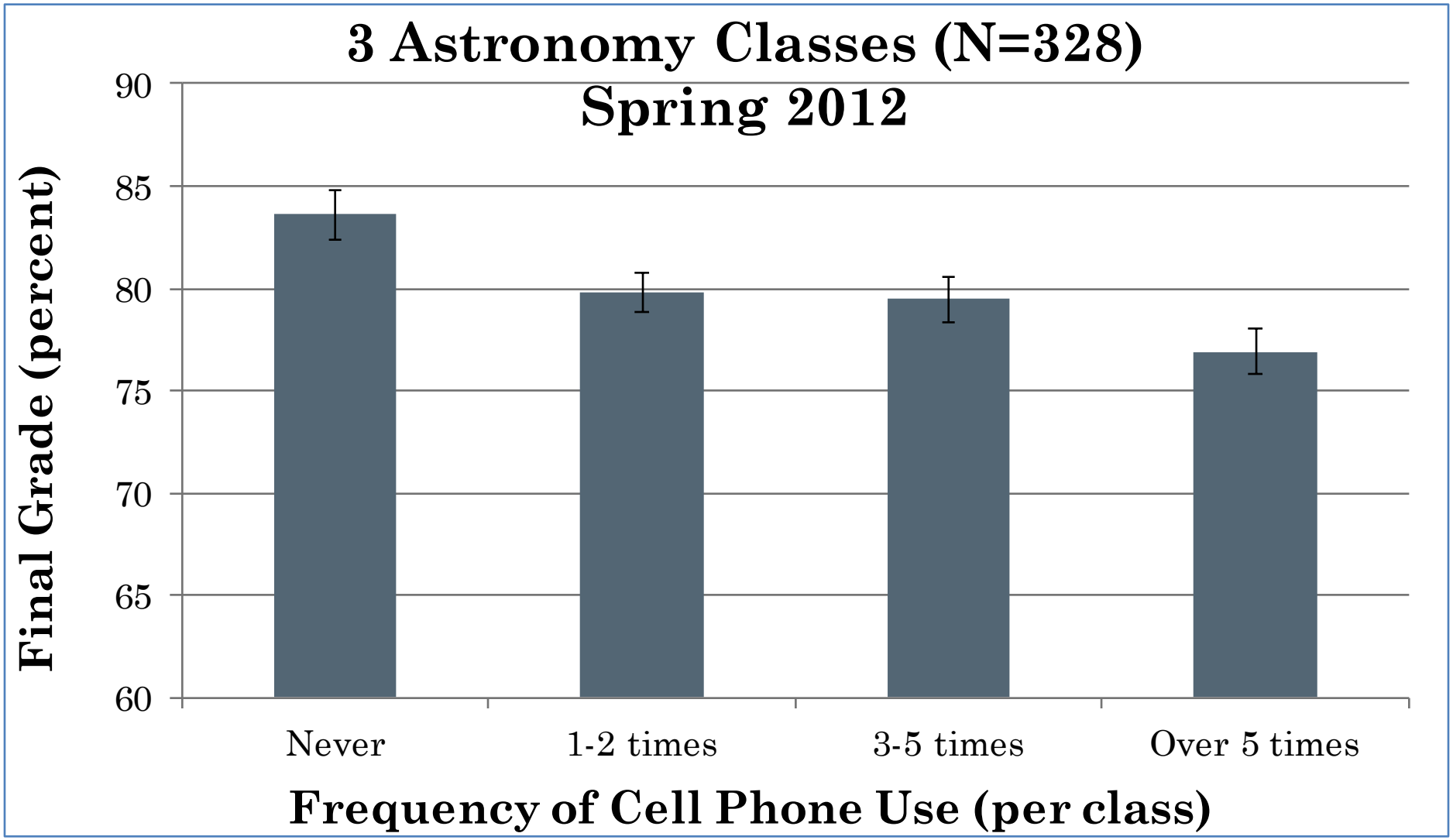
Notice my grading scale!

Save $10,000 now! Buy a DVD…



If there was a magic switch you could push that would raise your grade half a letter grade, would you push it?

There is, and this is what it looks like…


3 Astronomy Classes (N=328)
Spring 2012
Final Grade (percent)
90
85
80
75
70
65
60
Never
1-2 times
3-5 times
Over 5 times
Frequency of Cell Phone Use (per class)

In other words …

Students who use report using their cell phones in class score nearly half a letter grade lower, on average, than students who report never using their phones.

Phone policy: to use a phone, go out into the hall.

Laptop policy: sit in the front row, only use for the class.

Otherwise I will ask you to leave class.

The CU code of conduct prohibits interfering with another student's learning.

Pull out a piece of paper and write one thing you would like the course to cover….

Catherine Crouch

- Note that we have a video of Catherine's first day, using these slides, in the "video" portion of the archives.
- Attribute to Catherine Crouch, Swarthmore college

Course goals

- Master basic physics both qualitatively and quantitatively
- Build problem-solving skills
- Learn relevance to biology and medicine, chemistry, engineering

Learning physics

- Gaining not just information, but expertise
- Develop new ways of thinking!

How *not* to learn physics

Instructor pours knowledge into students.

Little knowledge is retained.

Student's Fault

Impedance mismatch between student and instructor

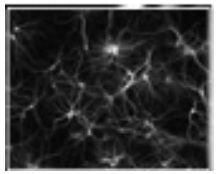
Instructor's Fault

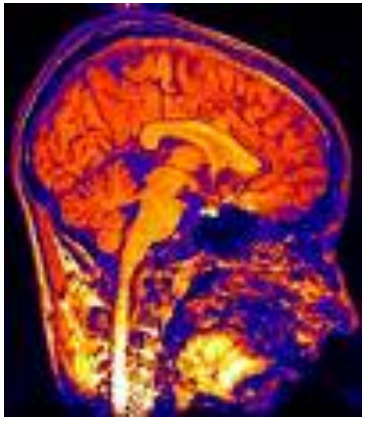
Learning is much more complicated

Leonard et. al. (1999). Concept-Based Problem Solving.

Learning physics

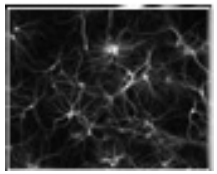
- My job:
  (1) demonstrate these ways of thinking
  (2) provide opportunities to try them out
  (3) provide feedback
- Your job:
  (1) practice!
  (2) help each other

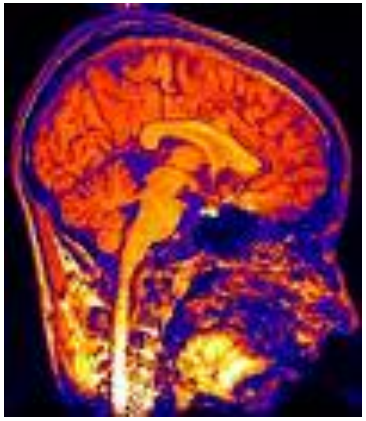




Opportunities to practice

- Reading follow-up assignments
- Questions in class
- Tutorials and questions in lab
- Mistakes are part of learning!





Course logistics: highlights

- Read syllabus carefully; note evening exams
- Explore course web site: records of questions asked and my notes from class, all handouts; Phys 4 S06 exams with solutions
- “Self-test” homework problems
- One “free late” problem set: arrange in advance
- Labs begin next week
- Lab sectioning —email Adam Neat
- Lab-related problems will be on the exams!

Andrew Boudreaux

- Please Credit to Andrew Boudreaux, Western Washington University

Some features of this course:

- Focus is on *your* thinking
  (rather than *my* presentation of the ideas)
- Focus is on concepts and reasoning
  (rather than *just* equations)
- Explicit attention to the process of learning

Focus on your thinking, not my presentation

Learning beyond surface level memorization requires active exertion . . .

. . . you will be doing the hard work, I am here to help.

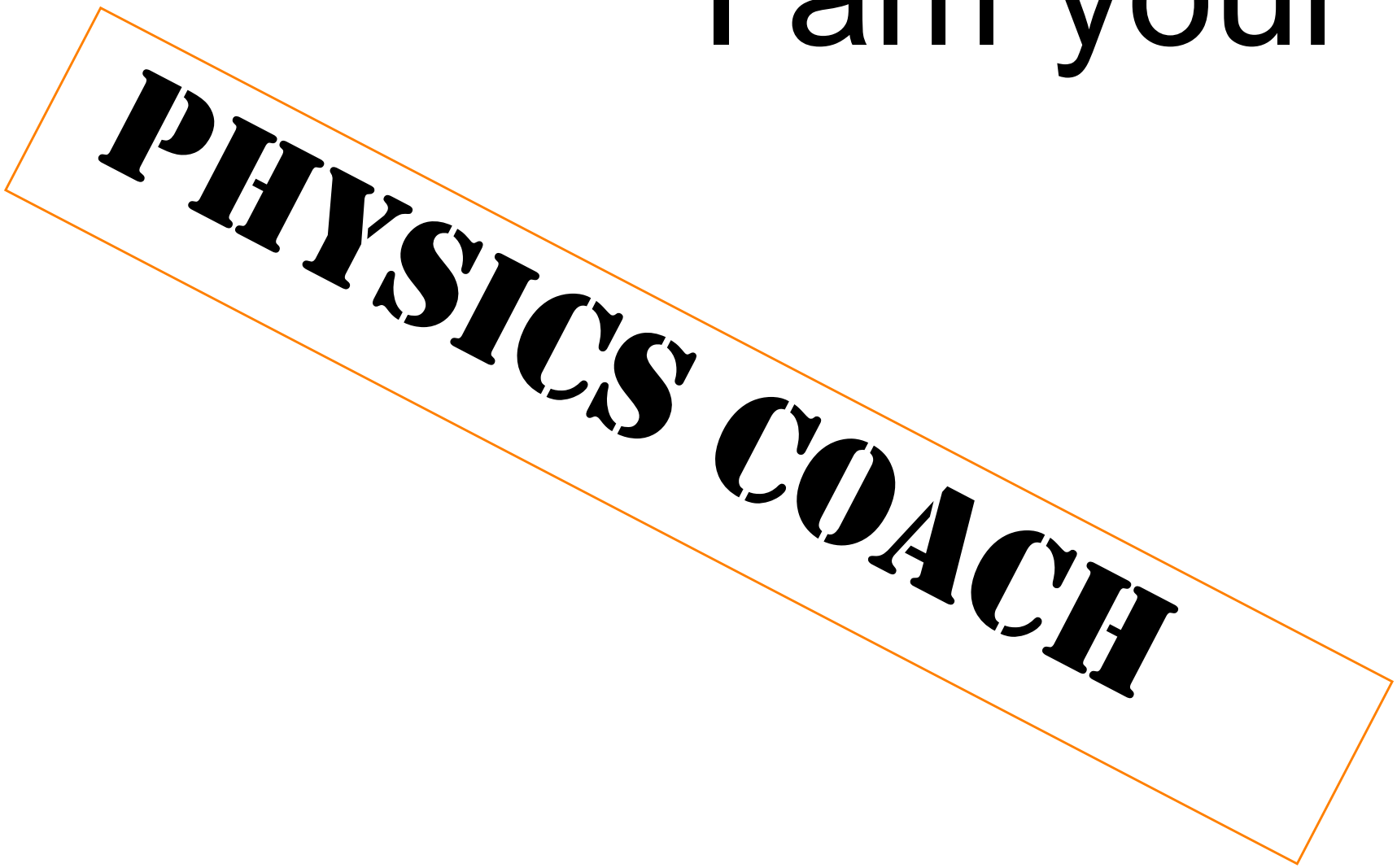
Focus on your thinking, not my presentation

Most importantly:

I will take the lead in creating a safe learning environment, in which students are comfortable taking risks, offering their ideas to the group, and being respectfully critical of the ideas of others.

An environment in which mistakes are opportunities for learning and expansion, rather than opportunities for demonstrating "innate" physics talent.

I am your



Focus on your thinking, not my presentation

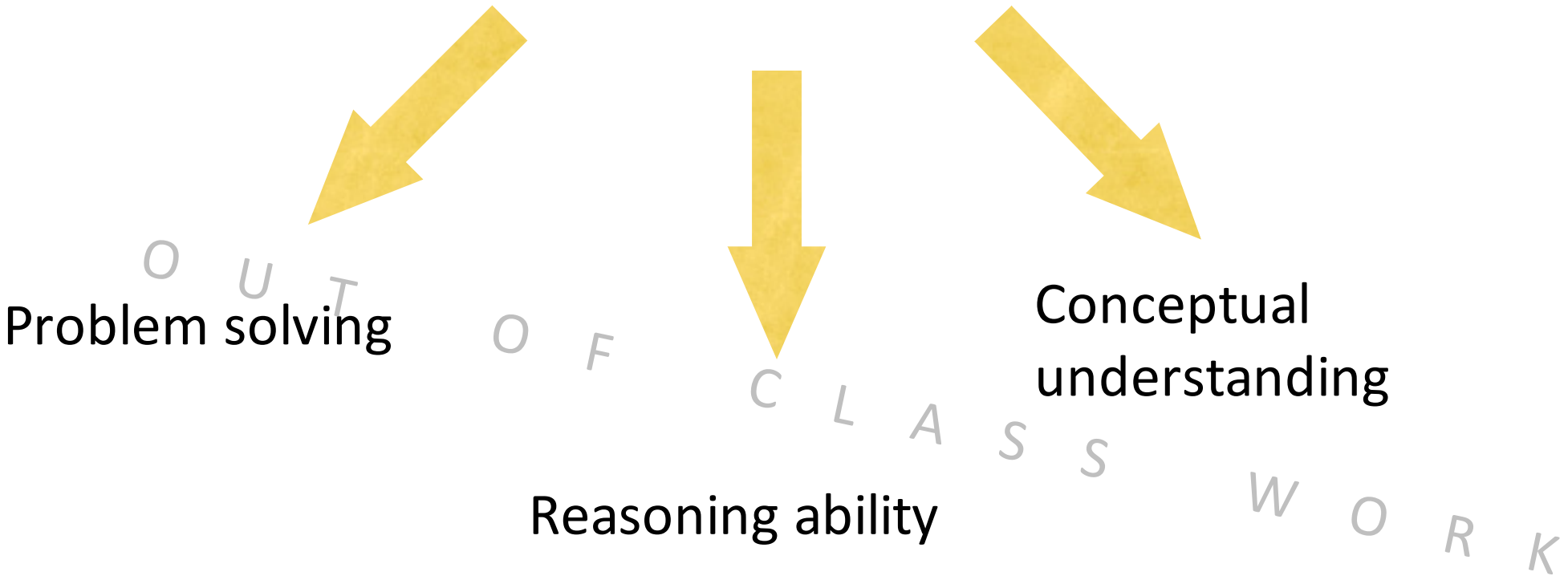
My role as physics coach:

- *Prompt you to evaluate your ideas and build class consensus*
- *Provide frequent feedback*
- *Teach by questioning rather than telling*
- *Provide encouragement*

Traditional set up:

Inclass presentation:

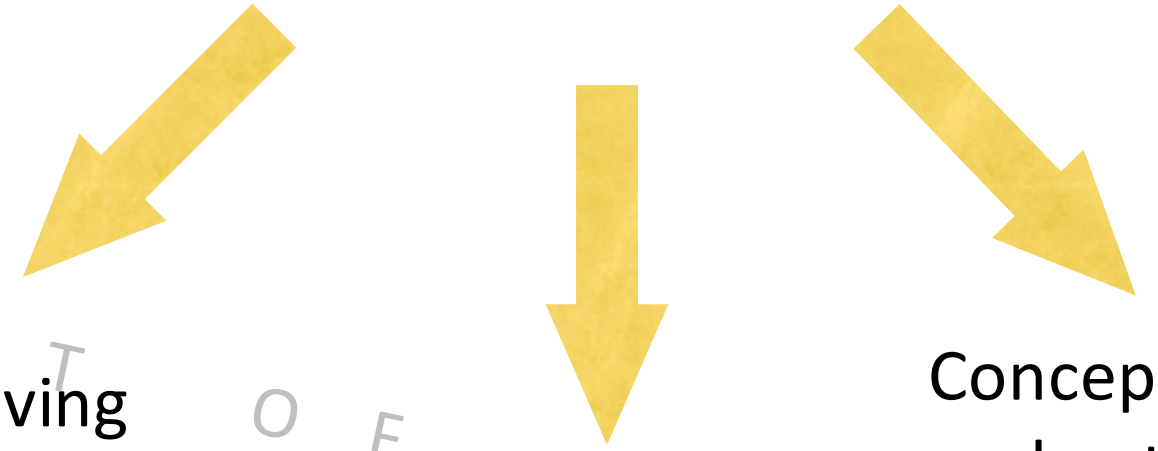
Big ideas, key results, main tools



Traditional set up:

Inclass presentation:

Big ideas, key results, main tools



Me talking . . .

Problem solving

Reasoning ability

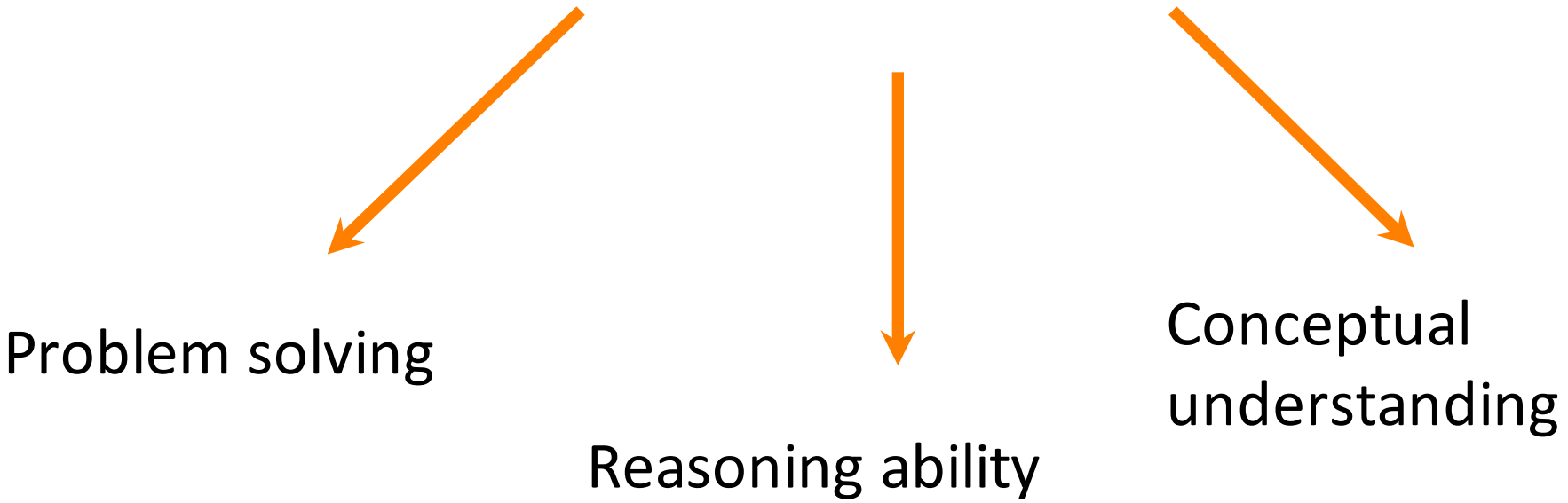
Conceptual understanding

O U T O F C L A S S W O R K

You suffering . . .

Let’s turn it around!

Out of class preparation:
Big ideas, key results, main tools



IN CLASS PRACTICE AND FEEDBACK

Focus on your thinking, not my presentation

What about the “right answer?!”

Focus on your thinking, not my presentation

What about the "right answer?!"

Textbook, homework solutions, office hours . . .

Focus on your thinking, not my presentation

What about the "right answer?!"

Textbook, homework solutions, office hours . . .

but generally not during class.

Focus on your thinking, not my presentation

This approach may take getting used to.

WWU Mission Statement and Vision

"*Western Washington University serves the people of the State of Washington, the nation, and the world by bringing together individuals of diverse backgrounds and perspectives in an inclusive, student-centered university that develops the potential of learners and the well-being of communities.*"

"*Western will build a stronger Washington by being an international leader in active learning, critical thinking, and societal problem solving.*"

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Final comment

Learning through *collaboration* and *consensus*.

Problem Solving in Physics

What is meant by “problem solving” anyway?

Problem Solving in Physics

What is meant by "problem solving" anyway?

The process of moving toward a goal when the path is uncertain.

If you know how to do it, it is not a problem!

Here is an *exercise:*

Nina drops a watermelon from the top of a three-story building, 10 meters above the ground. How fast is the watermelon moving when it hits?

Here is an *exercise:*

Nina drops a watermelon from the top of a three-story building, 10 meters above the ground. How fast is the watermelon moving when it hits?

Why is this not a *problem*?

The situation and given information are so narrowly constrained that there is a single, fairly obvious path toward a solution. An efficient way to solve is to match equations to givens, without ever thinking about physics concepts!

“Traditional” physics problems

- Can often be solved by manipulating equations
- Do not require visualizing the physical situation
- Do not require many *decisions*
- Can often be solved without knowing physics!

A reasonable strategy for these kinds of "problems":

- read problem
- categorize according to surface features (for example, "its an incline plane problem")
- recall memorized pattern of action and specific formulas for that type of problem
- manipulate equations until solution obtained

Here is a *problem:*

On a weekend trip to Seattle you decide to take Amtrak. But you are late finishing your physics exam so you arrive late to the train station. You run as fast as you can, but just as you reach one end of the platform the train departs, 30 m ahead of you down the platform. You can run at a maximum speed of 8 m/s and the train is accelerating at 1 m/s per sec. You can run along the platform for 50 m before you run into a concrete barrier. Will you catch your train?

Problems you will encounter involve:

- a "short story" in which you are the main character
- a (somewhat) plausible motivation or reason for you to calculate something
- objects that are real (or easily imaginable)
- no pictures or diagrams. You must visualize by drawing on your own experience.
- multi-step reasoning; no single single answers

This type of problem requires:

- *conceptual knowledge*
- *ability to visualize situation and determine a goal*
- *ability to choose applicable principles and relevant information*
- *constructing a plan*

and also....

Metacognitive Skills:

Managing effort and monitoring your understanding and progress.

A strategic approach to problem solving:

1. Represent/Describe the problem

- *draw a specialized picture*
- *draw a graph or other specialized physics diagram*
- *define variables and state the goal*
- *list knowns and unknowns*

II. Make a plan and carry it out

- *choose the applicable principles*
- *assemble the relevant equations*
- *outline a computation strategy*
- *work symbolically for as long as possible*

III. Assess the result

- *Is this value reasonable?*
- *Was the goal achieved? Are the units correct?*
- *Is the answer consistent with any special cases or limiting cases?*

These steps are a framework for helping you move forward even if you don't initially see how to get to the answer.

The steps are not meant to be a straightjacket. You may go forward and backward through the steps, return to an earlier step, etc.

Barbara Demmig-Adams

- Please Credit to Barbara Demmig-Adams, University of Colorado Boulder, and Alex Dutro-Maeda (illustrations)

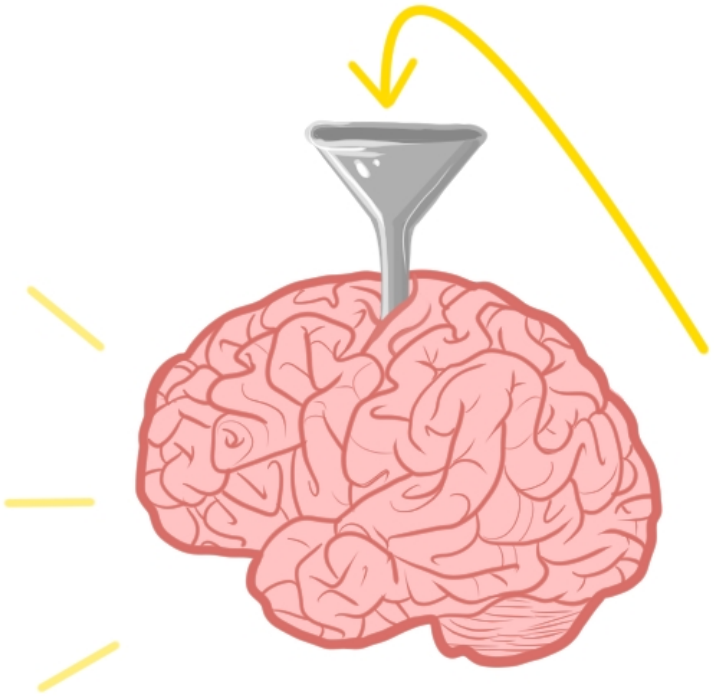
[Fun family photo to introduce myself as not just a prof, but also a mom of students just like them)

Illustration by Alex Dutro-Maeda

e.g., Exam Topics **I pledge to work to**

(1) provide the tools and transparency for your success in this class

(2) uphold standards to protect the long-term value of your degree from CU



EBIO1210: General Goal

To practice ***critical thinking***; to apply critical thinking skills to science

Illustration by Alex Dutro-Maeda

CU President Bruce Benson 2014:

Employers increasingly demand a workforce capable of critical thinking and analytical reasoning, effective communication, the ability to apply knowledge and skills in real-world settings, and teamwork.

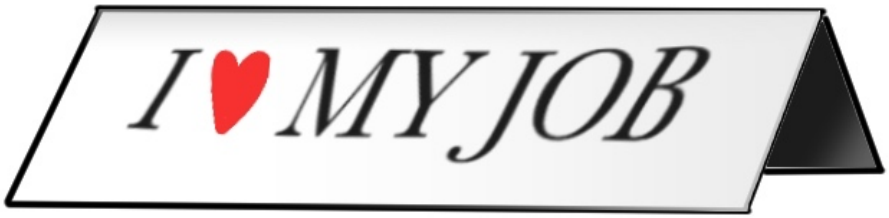


Illustration by Alex Dutro-Maeda

First half of Fall EBIO1210: Content-related Goals

1. To make connections between the ***molecules of life*** & their functions within organisms and the interaction of organisms with the environment

2. To follow ***information flow*** through biological cells; to identify indispensable ***cell features***

3. To follow ***energy flow*** through biological systems

while making connections to human health & society

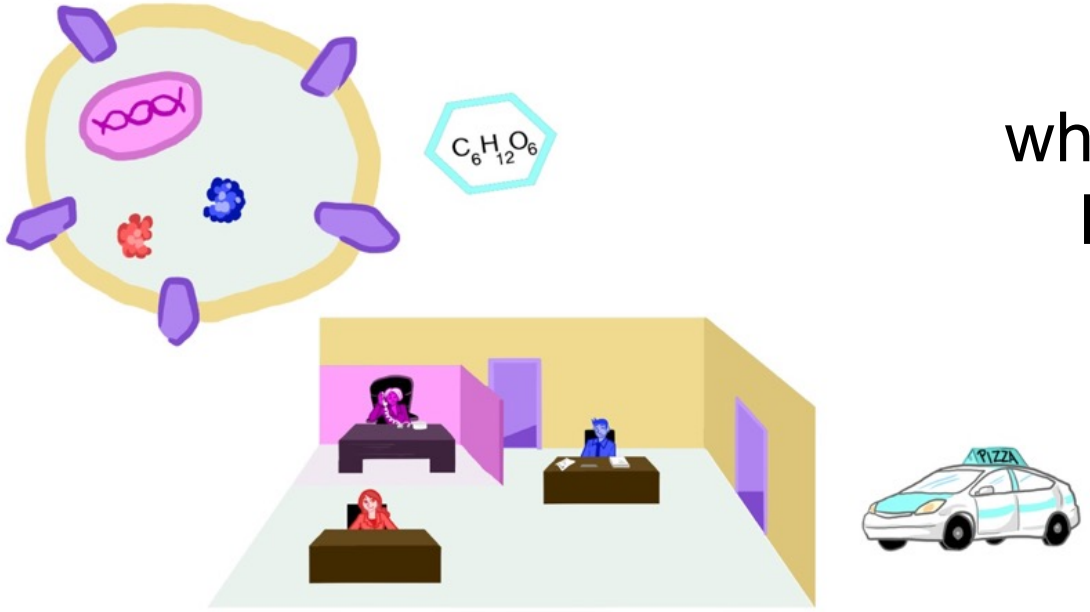


Illustration by Alex Dutro-Maeda

Strategy for success in this class

“Cramming” doesn’t work

Illustration by Alex Dutro-Maeda

Just as with an instrument or a sport, practicing several times a week works – "cramming" doesn't

Illustration by Alex Dutro-Maeda

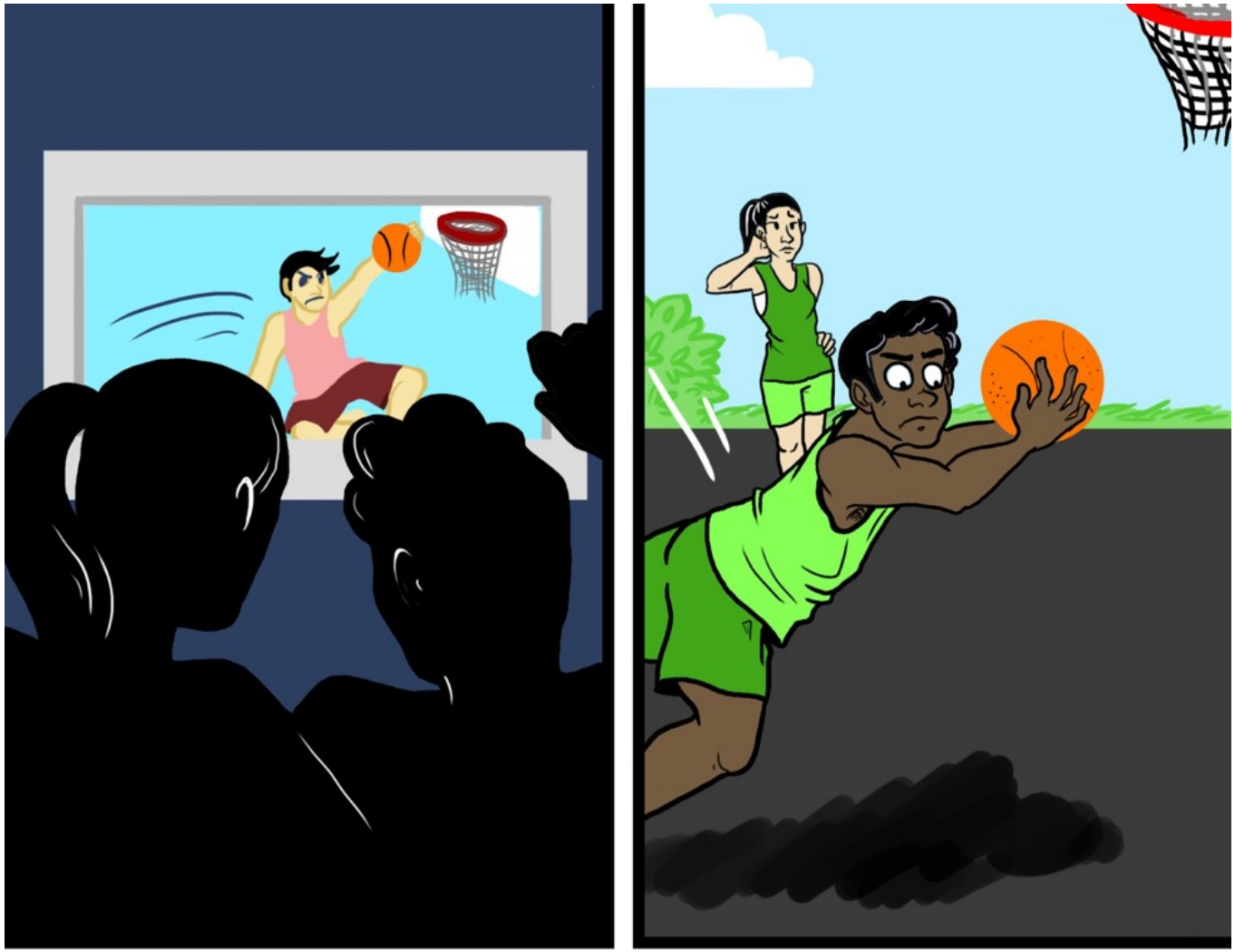
Illustration by Alex Dutro-Maeda

As is the case with a foreign language, understanding is easier than being able to say it yourself.

Say out loud what the reasons are why each answer option is correct or incorrect for all *iClicker* and homework questions.

Understanding is easier than being able to do it yourself

Illustration by Alex Dutro-Maeda



Understanding is easier than being able to do it yourself

Illustration by Alex Dutro-Maeda

Strategy for success in this class

All "Exam Topics" for Exam 1 are posted in D2L.

(1) *BEFORE* class: Download lecture files, read "Exam topics" and prepare for answering *iClicker* questions.

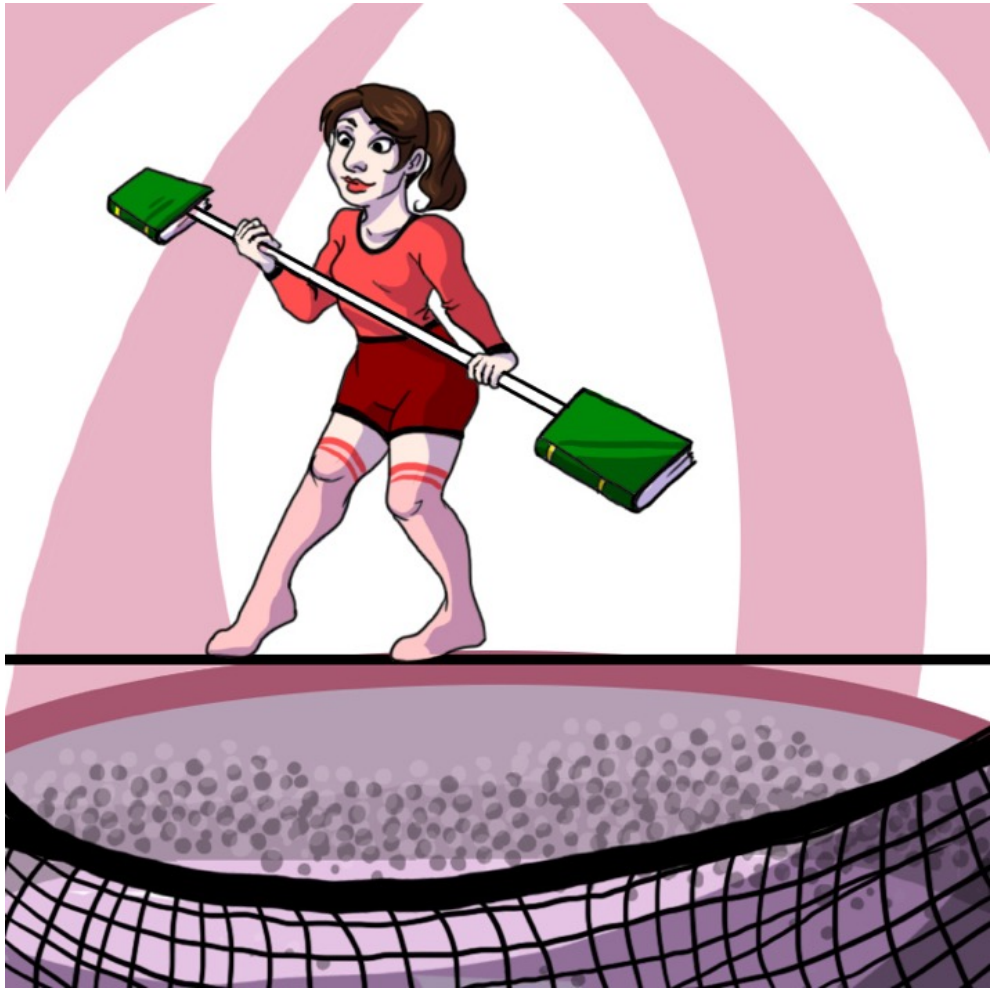
(2) To be able to *COUNT* the 150 min of class time per week as part of your exam prep, peruse the lecture PPT before coming to class.

(3) Use the *MasteringBiology* *HOMEWORK* to review *LECTURE* PPT.

(4) Go over material and *SAY OUT LOUD* what the reasons are *WHY* each answer option is correct or incorrect for all *iClicker* and homework questions.

Illustration by Alex Dutro-Maeda

Strategy for success in this class



Build your safety net:
Work with ETs; match them up; anticipate connections; if something is fuzzy, don't brush it aside since this will surely be on an exam; become immune to confusion and make your preparation solid enough to be able to select the correct answer no matter how the question is worded.

Illustration by Alex Dutro-Maeda

Other

Traxoline

It is very important that you learn about traxoline. Traxoline is a new form of zionter. It is monotilled in Ceristanna. The Ceristannians gristerlate large amounts of fervon and then bracter it to quasel traxoline. Traxoline may well be one of our most lukised protofoms in the future because of our zionter lescelidge.

Don't fool yourself about when you really understand

1. What is traxoline?
2. Where is traxoline monotilled?
3. How is traxoline quaselled?
4. Why is it important to know about traxoline?
5. How is traxoline similar/different from table salt?

Attreibuted to Judy Lanier

Bio sketch

- Got PhD in 2006 from Ohio State University
- Masters in Atomic, Molecular and Optical Physics (worked on cold atoms, atomic beams, interactions of atoms and light and built lasers!)
- Afterwards worked on Computational Particle Physics (the kind of thing they do to find theory for the Higgs Boson)
- Worked at Oregon State for 5 years
- Also work at the University of Cape Town, South Africa, helping to prepare students for graduate study in Astrophysics
- Dancer?? (haha!) Martial Artist (be afraid!) and DJ (I might actually be getting good at that)"